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In the Supreme Court of the United States

OCTOBER TERM, 1976

No. 76-1413

EX PARTE HENRY B. BRAINERD,
PETITIONER.

PETITION FOR A WRIT OF CERTIORARI TO REVIEW A DECISION OF THE UNITED STATES COURT OF CUSTOMS AND PATENT APPEALS

ROBERT B. RUSSELL
RUSSELL & NIELDS
One Boston Place
Boston, Massachusetts 02108
(617) 227-3835
Attorneys for Petitioner

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The Petitioner, Henry B. Brainerd, respectfully prays that a writ of certiorari issue to review the judgment and opinion of the United States Court of Customs and Patent Appeals entered on December 2, 1976.

Opinions Below

The opinions of the Board of Appeals of the Patent and Trademark Office, and of the Court of Customs and Patent Appeals appear in the Appendix hereto (A. 11 and A. 16).

Jurisdiction

The decision of the Court of Customs and Patent Appeals was rendered on December 2, 1976. A petition for rehearing was filed within 21 days and that petition was denied on January 19, 1977. This petition for certiorari was filed within 90 days of that date. This Court's jurisdiction is invoked under 28 USC §1256.

Question Presented

(1) Whether a *presumption* of knowledge on the part of prior artisans can be used to hold a patent claim obvious without there being in the record a specific reference showing what that knowledge was.

Statutory Provision Involved

§ 103. Conditions for patentability; non-obvious subject matter

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Statement of the Case

I. General

Petitioner comes before the Court seeking a review of a decision of the Court of Customs and Patent Appeals affirming the decision of the Board of Appeals of the Patent and Trademark Office denying petitioner's application for a patent. Petitioner's application is printed in the Appendix at A. 19, and the rejected claims appear at A. 40.

II. Subject Matter: Automatic Identification of Railroad Cars.

Petitioner's invention relates to the automatic identification of railroad cars. There are about 2,500,000 railroad cars in the United States today, and they all need to be identified repeatedly as they pass from place to place across the nation. Identifying them is a major problem. Prior to the invention of the application in question the railroads were spending between $.11 and $.20 of every revenue dollar on bookkeeping, and car identification was one of the largest elements of that expense. Today, however, the identification of railroad cars is being done automatically at far less expense by the Sylvania "Kartrak" system in which interrogating units are set up at the trackside, and as the cars go by, the interrogating unit scans a marker on the side of the car and picks up from it the identifying information. Nearly every railroad car in the United States and Canada today has a pair of these markers on it, one on each side. The markers are made up of stripes of red, white, and blue, "Scotchlite" tape arranged with additional black stripes to provide a four color-state coded pattern. As these markers pass the interrogator, the interrogator projects a light across the marker and as each stripe is illuminated in sequence it reflects light back into the interrogator which then separates the color responses, processes the code to identify the car, and then transmits the information by teletype to a central information station.

III. A Long Standing Problem

The problem was one of very long standing and prior to applicant's invention many unsuccessful attempts had been made to solve it, including those depicted in the prior art references cited by the Examiner.

IV. Petitioner's Solution

Petitioner first conceived that the problem could be solved using a marker made up of red, white, green, and black stripes as defined in his patent claims, in 1958. The material he selected for the colored stripes was "Scotchlite". "Scotchlite" is a retroreflective material. This means that light striking it is not diffused as with ordinary surfaces but, instead, is reflected back along the exact reverse of the incident light path. This made it possible for him to illuminate the marker by a broad beam of light emanating from a point source of light alongside the track and to collect the reflected light back at a receptor located also at the trackside as near as possible to the point source. Such a marker had unique advantages for the solution of applicant's problem. First, it effectively concentrated all of the reflected light back at virtually the same point at which the light started, and thereby permitted him to gather a maximum intensity of reflected light from *all parts* of each stripe. This in turn permitted maximum signal response and insured operation of the label even if dirt were partially covering the stripes. Secondly, it also permitted him to obtain strong reflected signals from the marker regardless of its position relative to the interrogator. Thus, the marker could be high, low, near or far, and since the return light always came back to the same point source, the variations in position of the marker were unimportant. It will be understood that railroad cars differ vastly in height and width, and together with changes in loading, it is impossible as a practical matter to have the marker always

come at the same position relative to the interrogator. Therefore, this advantage was very important in context. In addition, petitioner's use of four possible color states for each stripe and arranging the code for sequential scanning provided a maximum of information for a minimum of expense.

V. Commercial Success

Today, there are approximately 5,000,000 markers which meet the definition of petitioner's claim in use on the railroad cars of America.

VI. The Rejection of Petitioner's Claims

Petitioner's claims were denied by the Patent Office as being obvious in view of two prior art references plus "common knowledge".

The two references were Orthuber (A. 41) and Kolanowski (A. 49). The "common knowledge" had to do with "Scotchlite", but in spite of petitioner's traversal of this rejection, no specific reference was cited showing the details of what was supposed to have been "commonly known" or that it would have been known to the ordinary artisan (Sec. #103) "in the art to which said subject matter pertains". The rejection was based solely on obviousness under Section #103, and not on anticipation under Section #102. In fact, it is clear that neither of the specific references cited, nor their combination with "Scotchlite" completely discloses petitioner's invention. Orthuber's marker is a diffuse reflector and has only three color states (i.e. red, blue and black — note: Orthuber's spaces between his stripes give no signal response (see Fig. 1), therefore they do do not give a "white" signal response. They are effectively black). Kolanowski's marker is a diffuse reflector and has only two color states, white and black. It is not arranged for sequential illumination or sequential coding. Both Orthuber and Kolanowski require the marker

to be placed very accurately in relation to the interrogator, which is impossible in the railroad context. Thus, neither Orthuber nor Kolanowski nor their combination with Scotchlite actually adds up to petitioner's claimed marker.

The failure of the Examiner to cite a specific reference from which the "commonly known" properties of Scotchlite relevant to petitioner's special problem could be determined was an important missing element in the rejection. Petitioner's witness Wilcox, who was a salesman of "Scotchlite" testified that the significant features of Scotchlite which made it useful in optical sensing devices were not generally known by those skilled in the art.[1] In addition, petitioner offered evidence showing that what was actually known about Scotchlite would contraindicate the usefulness of colored stripes of Scotchlite for close-up object identification, such as its *poor* reflectivity at short range and the relatively poor reflectivity of the colored "Scotchlite" required in petitioner's marker, compared to the white form. The Examiner, however, simply repeated the "common knowledge" rejection without so much as citing a single reference to refute petitioner's evidence, and the Board affirmed.

The Court, however, changed the basis for the rejection holding that petitioner's invention was obvious because "Scotchlite" had been previously known for such uses as highway signs and safety markers, and the ordinary artisan is, therefore, "chargeable" with whatever further knowledge might be required to arrive at petitioner's invention. The Court, therefore, got around the requirement that a

[1] "The Witness: You refer to an ordinary person in the field. In what field?

Q. In the field of optical sensing devices.

A. I would say that the ordinary people in the field of optical sensing devices were not generally aware of retro-reflective materials and their characteristics that would be significant here." (Exhibit Q, p. 129).

specific reference be cited in support of a traversed "common knowledge" rejection, *Ex Parte Nouel,* 158 USPQ 237, *MPEP* Sec. 706.02(a), simply by *presuming* that the ordinary artisan would have the knowledge which the Court assumes would have been in the missing reference. Precisely what was presumed to have been known, however, was not identified.

The fallacy of the Court's decision lies in the fact that one cannot assume what a prior art reference will disclose. For example, the prior art references dealing with Scotchlite, of which petitioner is aware, show that in the highway sign and safety marker context, the refectivity of white Scotchlite is not as great as that of ordinary paint at distances of less than 25 feet. Of course, the reflectivity of colored Scotchlite is even less. If such references had been cited, petitioner could have overcome them rather easily. The Examiner, however, fell back on "common knowledge" and refused to cite a specific reference, and the Court went even further and held that the missing information can be *presumed* to have been known.

Petitioner submits that this takes the presumption of knowledge of the prior art too far. It is as though the Court were saying "Because we now know that "Scotchlite" arranged as petitioner did it, makes a uniquely useful marker for close-up automatic railroad car identification, this knowledge must be presumed to have been previously known from the mere fact that the material was previously known to be useful at long range and in quite a different context."

In his dissenting opinion (A. 18), Judge Baldwin aptly summarized petitioner's view when he stated "I regard the majority's jump from road signs to railroad cars as manifesting the kind of hindsight reconstruction which undermines out patent system". He did not believe, as we do not, that the missing knowledge can be *presumed* by hind-

sight. Judge Baldwin also pointed to the length of time that Scotchlite had been in existence prior to petitioner's invention and to petitioner's commercial success as indicating lack of obviousness. More important, however, Judge Baldwin pointed out that the majority opinion is inconsistent with prior unanimous opinions of the Court, see generally *In re McLaughlin*, 58 CCPA 1310, 443 F2d 1392, 170 USPQ 209 (1971).

It should also be noted, however, that two additional and undisputed facts strongly support the lack of obviousness of petitioner's invention. The first of these is that those who had been tempted to try Scotchlite in the same context as petitioner, not only failed to arrange it the way petitioner did, but failed to see its unique usefulness and discarded it. The Court below states parenthetically (A. 17) that Readman, one of those who had discarded it, eventually returned to the use of "Scotchlite". This is quite true but it is totally irrelevant, because of the dates (which the Court below did not mention). Readman tried, but rejected "Scotchlite" two years *before* applicant's invention. He did not return to it until *long after* petitioner's invention, and after Sylvania's success with it had become well known. Therefore, Readman's return to it at the later date has no relevance at all to the question of obviousness at the earlier date. Readman's earlier effort was plainly and simply an abandoned experiment and, as such, it is an indication of *lack* of obviousness; *Lynn* v. *Bausch & Lomb Optical Co.*, 224 F2d 520 (106 USPQ 1 (CA 2, 1955)).

Perhaps the strongest proof of lack of obviousness offered by petitioner was the *lack of concurrent suggestion* by others. No one else suggested either Scotchlite or applicant's arrangement of it in stripes, having four color states, prior to petitioner, and even in 1961, some three years after petitioner's invention, among the 30 different proposals submitted to the railroads for automatic car identification,

only four were considered practical and only one of those four even suggested using "Scotchlite" let alone petitioner's arrangement. That suggestion was Sylvania's and it also incorporated petitioner's arrangement. It was the one which was eventually selected, it is identical to petitioner's marker, and it is the marker which is today being used on the railroad cars of America. If such a marker had been obvious, one might suppose that *someone else* would also have suggested it over such a long period of time.

This is strong evidence of lack of obviousness. Opposed to this, there was no evidence in the present record of obviousness beyond petitioner's admission that Scotchlite was previously used for highway signs, street signs, safety markers, etc., from which the Court below drew a presumption of additional knowledge on the part of the ordinary artisan which Judge Baldwin characterized as "hindsight".

The critical point, however, is that the majority has *extended* the scope of the presumption of knowledge of the prior art beyond any prior case of which we are aware. In all other cases, the prior art references are *cited* and their content is at least of record. In such cases it is usual for Courts to hold that the prior artisans are presumed to have been aware of the content of those references. No prior case, however, has gone so far as to hold that knowledge, which is not described or defined by the Court and which cannot be determined from the record by reference to a document or other evidence, can be *presumed* to have been known. Accordingly, the case at bar represents a new extension of the presumption of knowledge, beyond any prior case of which we are aware.

Such an extension of the law is, in our opinion, erroneous and it sets a dangerous precedent which, to use Judge Baldwin's words, "undermines our patent system". Applicants for patents should be entitled to know specifically what is being cited against them so that specific answers

can be prepared. Conversely, it is unfair and contrary to the intent of the patent laws to reject an application for a patent on an undefined prior art reference and to hold that the teaching of that undefined reference can be *presumed* to render the invention obvious.

The situation is different when a specific reference is cited. At that point, the applicant can at least grapple with the issue, but, not having a specific reference to discuss, and being forced to contend solely with the Court's *presumption of knowledge,* the applicant has a hopeless task. He is defeated before he starts. This situation was particularly disastrous for petitioner in the case at bar because petitioner had ample evidence to show why the prior art references dealing with Scotchlite, of which petitioner was aware, contra-indicated its suitability in petitioner's context. Thus, if the Examiner had cited any one or more of those references, applicant could have presented persuasive arguments. The only reference petitioner could not defeat was the one in the shadows which was never shown him, but from which the Court drew the *presumption* of sufficient knowledge to defeat him but without giving any details as to what that knowledge was.

Such is rough justice. If followed, it would defeat many a good patent, and we are confident that this Court will not allow it to stand.

Reasons for Granting the Writ

The decision below is in error in a way which will have serious and damaging consequences for the patent system unless corrected. The Court below's extension of the presumption of knowledge on the part of the ordinary artisan to include knowledge which is not specifically before the Court (except in petitioner's patent application) is illogical and erroneous. While it may be appropriate for a Court to

presume that prior artisans are aware of prior art references of *record,* provided those references apply "to the art to which the subject matter pertains" (Sec. 103), it is not proper to presume knowledge on the part of the artisan of prior art references *not of record* and which knowledge can only be deduced from the successful use of the invention in question.

This error of law could have far reaching consequences. If allowed to stand many meritorious inventions would be denied patentability because it permits the Courts to presume things to have been known without giving the inventor proof of what was actually known or an opportunity to explain the reference or to distinguish over it. Accordingly, not only should the decision below be reversed, but also a decision of this Court is needed to lay the guidelines of how far the Courts and the Patent Office can go in denying patentability based on the presumption of knowledge on the part of the ordinary artisan.

Additionally, a highly meritorious invention having major economic significance is here involved. Unless this petition is granted and the decision below is reversed, it will go unrewarded.

Conclusion

Therefore, petitioner respectfully prays that the Supreme Court grant this petition to review the decision of the Court of Customs and Patent Appeals.

Robert B. Russell
Russell & Nields
One Boston Place
Boston, Massachusetts 02108
(617) 227-3835
Attorneys for Petitioner

APPENDIX A

Paper No. 20

[55] **Opinion and Decision of Board of Appeals, December 31, 1975**

Before Bennett and Henon, Examiners-in-Chief, and Lindquist, Acting Examiner-in-Chief.

Henon, Examiner-in-Chief.

This is an appeal from the decision of the examiner rejecting claims 1-6, which are all the claims in the application.

The invention, as disclosed, relates to a coder marker for use on the side of railway cars to permit the automatic identification of such railway cars. The system directs a beam of light having a frequency spectrum including at least two distinct and distinguishable frequency bands of light at the side of the passing railway car at an angle substantially divergent from the normal to the surface of the marker, and relies on the retro-reflection of the incident light beam back along a reflected trajectory lying as close as [56] possible to the axis of the incident ray. The marker includes a plurality of strips of retroreflective material comprising a multiplicity of small closely spaced retro-reflective lens systems distributed across the full length and width of the strips.

Illustrative claim 1 is as follows:

> 1. A coded light-reflective marker for use in a railroad car identification system of the type adapted to identify individual cars bearing said markers and moving sequentially along a predetermined path, said system including means for scanning said cars and said markers with a beam of light having a frequency spectrum including at least two distinct and distinguishable frequency bands of light together with optical means for projecting said beam from a source which is substantially a point to discrete portions of said markers at an angle of incidence substantially divergent from normal to the plane of said markers and for receiving light retro-reflected from said portions of said markers at a point as close as possible to said source; said marker comprising: elongated strips of retro-reflective material comprising a multiplicity of small, closely spaced retro-reflective lens systems, imbedded in said strips, and distributed across the full length and width thereof, each said system including means for retro-reflecting incident light, concentrating same back along, and close to, the same axis as that of the incident light where said axis is at an angle substantially divergent from normal to the plane of said strip, said strips arranged in segmented permutatively patterned areas adapted for variously (a) retro-reflecting, from substantially all areas of their length and width, each said band individually, (b) so retro-reflecting at least two said bands simultaneously, and (c) not retro-reflecting any of said bands.

The references relied on by the examiner are:

Orthuber	2,899,132	Aug. 11, 1959
Kolanowski et al	3,106,706	Oct. 8, 1963

Claims 1-6 stand rejected under 35 USC 103 as obvious over Orthuber viewed alone or in combination with Kolanowski et al. The examiner contends that Orthuber teaches the use of a coded marker having two colors separated by blanks for conveying coded information. He also contends that as broadly recited in the claims the retro-reflective characteristics of materials such as "Scotchlite" were well known. The examiner [57] concludes that the use of retro-

reflective materials as colored markings for a coded marker would be obvious. The examiner points to Kolanowski et al as an example or teaching of using a coded bar member on the side of a railway car. He also submits that both references show human-readable markings accompanying the coded strips, and that such a feature would be obvious on the side of a railway car.

Appellant argues that the various exhibits filed in this case demonstrate the nonobviousness of the claimed invention. Moreover, he asserts that the applied prior art does not disclose a marker using retro-reflective material. Appellant further contends that the Orthuber marker would be inoperative for use in automatic car identification because of specular interference. A further contention by appellant is that the properties of "Scotchlite" were not recognized by those skilled in the art as suitable for automatic car identification. It is also argued that the use of Orthuber's marker in the system of Kolanowski et al would yield an inoperative device.

We have carefully reviewed the prior art, the contentions of the examiner and appellant and the several exhibits submitted by the appellant, and we conclude that claims 1-6 would be obvious within the meaning of 35 USC 103 in view of Orthuber alone or Orthuber in combination with Kolanowski et al.

In our view, the color coded marker of Orthuber, which is disclosed as being placed upon moving packages of merchandise, is just as readily applicable to other moving units to be identified, such as railway cars. The cited patent to Kolanowski et al is one example of using coded strips to identify a railway car. It also seems to us in view of the well known reflecting characteristics of prior art retro-reflective [58] materials, that it would be obvious to one of ordinary skill in the art to use such materials in the Orthuber device. Although appellant has urged that the

retro-reflective properties of "Scotchlite" were not recognized as suitable for use in automatic car identification, we note that both Mr. Readman and Mr. Wilcox in their depositions (exhibits M and Q, respectively) testified that they considered the use of retro-reflective materials for automatic car identification as an obvious choice. Their opinions are significant because Mr. Readman had experimented with retro-reflective materials for identifying buses, and Mr. Wilcox was a salesman who well understood the capabilities of "Scotchlite". Hence, broadly speaking, we find that the use of retro-reflective color coded markers for railway cars would be obvious in view of the teachings of Orthuber and the known properties of such retro-reflective materials.

We have reviewed exhibit F in which appellant has attempted to show how the claims at bar differ from previously appealed claims in parent applications to this application. Taking claim 1 as exemplary, we agree with the examiner that lines 14-19 of the claim merely define the characteristics of "Scotchlite", a well known retro-reflective material. As noted *supra*, we consider the use of such a retro-reflective material in automatic car identification as obvious. Lines 7-13 and 19-21 of claim 1 set forth that the angle of incident light and retro-reflected light is substantially divergent from normal to the plane of the marker. We note that the testimony of both Mr. Readman and Mr. Wilcox indicates that such angles were standard when using retro-reflective materials.

[59] Appellant has argued that the prior art cited by the examiner does not teach the formation of all combinations of two logic signals. We are of the view, that the formation of four unique output signals in response to two binary inputs is notoriously well known in the digital logic art and would be completely obvious to a routineer in the art.

The limitations added by dependent claims 2-4 were

essentially considered in the appeal of parent application serial No. 590,438, and we agree with the result reached by the Board of Appeals in that application that claims 2-4 add limitations which would be obvious within the meaning of 35 USC 103 in view of the teachings of Orthuber and the known properties of retro-reflective materials.

Claim 6 recites the placement of a standard alphanumeric character adjacent the coded pattern representing that character. Appellant argues that the prior art cited by the examiner does not teach such a feature. We view this feature, however, as a common expedient in enabling humans to visually interpret a machine-readable code. Inclusion of this feature in an automatic car identification system would be obvious to one having ordinary skill in the art.

We note in passing that we have reviewed the decision in *Sylvania Electric Products, Inc.* v. *Brainerd*, 369 F. Supp. 468, 181 USPQ 536 (D.C. Mass., 1974) which was affirmed, 499 F.2d 111, 182 USPQ 385 (C.A. 1, 1974) in which the validity of a patent issuing on a parent application to this one was decided. We find nothing inconsistent between our conclusions and the conclusions reached by the courts. Moreover, we view the courts' findings as buttressing our own.

[60] In summary, the decision of the examiner rejecting claims 1-6 under 35 USC §103 as obvious over Orthuber alone or in combination with Kolanowski et al is affirmed.

AFFIRMED

BOARD OF APPEALS

(s) Rodney D. Bennett Jr.
Examiner-in-Chief

(s) (Illegible)
Examiner-in-Chief

(s) William F. Lindquist
Examiner-in-Chief
(Acting)

APPENDIX B

NOTE: This opinion will not be published in a printed volume because it does not add significantly to the body of law and is not of widespread interest. It is a public record. It is not citable as precedent. The decision will appear in tables published periodically.

UNITED STATES COURT OF CUSTOMS AND PATENT APPEALS

Patent Appeal No. 76-645.
Serial No. 121,108.

IN THE MATTER OF THE APPLICATION
OF
HENRY BOWEN BRAINERD

Decided: December 2, 1976

Rich, Judge.

DECISION

The decision of the Board of Appeals is *affirmed.*

OPINION

In view of appellant's admission that the retroreflective material trademarked "Scotchlite" was in public use "for highway signs, street signs, safety markers [including markers on railroad cars], etc.," testimony that some or even many individuals did not have actual knowledge of its retroreflectivity cannot represent the knowledge of "a

person having ordinary skill in the art." Such a person clearly deals with reflective markers and must be charged with knowledge of such markers in widespread public use. That the angle of incident light and retroreflective light may be substantially divergent from the normal to the plane of the marker is simply descriptive of retroreflectivity. The advantage of employing such an angle of incidence appears to have been expected. The charge of error on the part of the board or the examiner on these points is, therefore, not well-founded.

Contrary to appellant's arguments, the so-called abandoned experiments of Ernst and Readman do not establish the unobviousness of "Scotchlite" or other retroreflective markers in an ACI system. Even as described by appellant, the Ernst comparison of white "Scotchlite" to white paint showed "Scotchlite" to be superior in reflectivity. Readman clearly thought that "Scotchlite" could be useful in an ACI system, but turned (temporarily, it seems) from using it in his particular system because of the "long scan requirement with the photo-electric detector devices available at that time."

As to commercial success, appellant has pointed to little in the record identifying the marker used in the Sylvania "Kartrak" system with his invention. Further, he has not shown that the success of the Sylvania *system* is due to the marker employed in that system.

The board did not state a new ground of rejection when it referred, in passing, to judicial decisions involving the patent issued on appellant's parent application.

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UNITED STATES COURT OF CUSTOMS AND PATENT APPEALS

Patent Appeal No. 76-645.
Serial No. 121,108.

IN THE MATTER OF THE APPLICATION
OF
HENRY BOWEN BRAINERD

BALDWIN, Judge, dissenting.

I regard the majority's jump from road signs to railroad cars as manifesting the kind of hindsight reconstruction which undermines our patent system. The majority was apparently not impressed with the fact, noted by the solicitor, that the original "Scotchlite" patents had expired prior to the appellant's invention. Thus, it took more than seventeen years for anyone to recognize this relatively simple invention. This is inconsistent with my ideas of obviousness. Whatever inferences of obviousness the majority may derive from the prior art are, I feel, clearly rebutted by the evidence of commercial success. See generally the unanimous decision in *In re McLaughlin*, 58 CCPA 1310, 443 F.2d 1392, 170 USPQ 209 (1971).

APPENDIX C

[1] **Application of Henry Bowen Brainerd, Filed March 4, 1971, Serial Number 121,108, For Light Reflective Marking For Identification System.**

This application is a continuation of my co-pending application, Serial No. 590,438, filed October 28, 1966, said Serial No. 590,438 being a continuation of my then co-pending application, Serial No. 321,383, filed October 8, 1963, said Serial No. 321,383 being a division of my then co-pending application, Serial No. 824,542, filed July 2, 1959.

This invention relates generally to an identification system and is more particularly concerned with a fully automatic identification system for moving vehicles such as railroad vehicles.

It is not an exaggeration to state that in considerable measure the prosperity of our nation depends upon the health and prosperity of the railroads, the backbone of our transportation system. No more effective scheme has been devised to transport large numbers of people and goods from one point to another safely, economically and comfortably. While the role of the railroads has changed with the improved technology of the automobile and aircraft industries there is no doubt that the railroad system is a vitally necessary part of our transportation network.

Yet history has frustrated the capabilities of American railroads in finding their proper role in respect to the other forms of transportation. The regulatory practices [2] of the Interstate Commerce Commission and the Public Utility Commissions of various states, the railroad brotherhoods and in part the railroad managements themselves have contributed to the problem. Handicapped partly by the tradition, by union restrictions and by a maze of regulation to which no other private sector of the economy is subject,

the railroads for many decades have sought to deal efficiently with the day-to-day handling of freight and passengers within the statutory rate framework permitted them. As a result, for these many decades there has been continuing analysis of the economics of railroad operations. This in turn has brought forth a multitude of proposed solutions and inventions designed to decrease cost and increase efficiency and safety in the handling of railroad vehicles. Yet in many phases of railroading the number of man hours required to deal with matters substantially routine and repetitive have not been satisfactorily reduced.

New schemes are constantly being introduced to facilitate the assignments presented to the railroads in each day's operations. But these improvements, heretofore, have been generally no more than the streamlining and refining of the efforts of men and use of man power.

The problem of identifying and assorting freight cars is one of the major tasks of practically every railroad. It is a function performed in a classification yard and is comparable to the function of a sorter in a post office who places letters into various mail sacks according to their destination. A classification yard is the center at which arriving freight trains are broken up and the cars sorted according to destination to form new trains.

[3] Cars are loaded at private sidings or public freight depots. A document called a waybill is made out for each car giving the number, routine, destination, consignee, shipper, contents, special instructions, and any other pertinent information. This waybill accompanies the car from origin to destination of the shipment in the charge of the conductor of the train in which it is hauled.

Loaded cars in metropolitan areas are taken by a switcher to assembly yards. At outlying points cars are picked up by a way freight. Cars go most of the distance in through trains, and are eventually set out at destination by a way

freight or switcher. Usually, except for a few short hauls, a car goes through one or more classification yards.

In most cases, the cars are brought to a freight yard in the order in which they were picked up and are not sorted for their destination. Up to the early 1900's all classification was done in "flat" yards, where a switch engine shuttled back and forth hauling cars out of one track and shoving them onto another. The yard conductor referred to his handful of waybills, while the crew threw switches, coupled and uncoupled cars, released and set brakes in response to his hand signals. This is still done to some extent.

About the beginning of World War I, "hump" yards were introduced. While a locomotive pushed cars slowly over the hump a rider got on each car to handle the brakes, a man uncoupled each car and the yard conductor signaled track numbers to a crew of switchmen who threw the switches by hand.

[4] Somewhere about this time it became common practice to walk down a train and write down car number in order, then fill in track numbers from the waybill information to form a "switch list". This was much more convenient for switching and protected the waybills from rough handling.

In the 1920's the car retarder was introduced. This is a power operated device along the track which presses on car wheels by manual control and slows the car down, eliminating the need for riders. Along with this mechanization the yard switches were made power operated. This allowed three or four men to handle the retarders and switches for an entire yard. Each man received a duplicate copy of the switch list, either by pneumatic tube or by teletype.

In the 1940's the control of the retarders was automated with an electronic analog computer, which could take into account the weight and "rollability" of each car, the curve

resistance to the selected track, the number of cars in the selected track and wind velocity, so that each car would leave the last retarder at a speed that would let it couple onto the car ahead without damage. Swith controls were arranged for pre-programming, and in some cases the teletyped track number can control the switches without any action by the operator. With this system one man can supervise the retarders and switches of the longest yard.

During this same period there was a trend toward fewer and bigger classification yards made possible in part by the increased use of semi-automatic techniques. Today, cars out of New York and Boston, for example, may be classified at Selkirk for as many as forty destinations. Several [5] destinations will form "blocks" in a train; each block can be set out in a simple switching operation instead of reclassifying the entire train. This saves both car time and operating costs. A car from Chicago to Boston which might have stopped eight or ten times for classification, with a delay of a day or more at each yard during the era of flat switching, can now travel the same distance with only two or three stops, each stop requiring only half a day or less.

At the present time, the clerical work of recording the car numbers, checking against waybills, and preparing switch lists has emerged as a major item of labor costs and delay in the classification, switching and routing of cars. Costs and delays have been somewhat reduced by using closed circuit television techniques. A TV camera at the entrance of a receiving yard scans incoming trains and a clerk in the yard office reads the car numbers from the TV monitor screen into a tape recorder.

When a train pulls into a receiving yard the conductor sends the accompanying waybills to a clerk who arranges them in order with the car numbers as tape recorded and prepares the switch list from this information. This list

may be typewritten then carried by pneumatic tube, transmitted by teletype, punched in tape for later teletype transmission, or punched in IBM type cards.

[6] Modern communications techniques such as two-way radios, paging loudspeakers, and two-way loudspeakers, direct switch engines moving blocks of cars to the departure yard, men connecting air brake hoses, and other necessary operations.

While much of the hard and dangerous physical labor of the classification process has been reduced there is still need for personnel to observe, record, verify, and supervise the various sorting operations. What has been required, therefore, is a means of automatically identifying railways cars, storing the information, and then matching the identities of the cars to their destination in order to assemble cars in groups by destination.

It is an object of my invention accordingly to provide completely automatic means for the identification of railroad cars.

Another object of the invention is to provide fully automatic recording and storage means for the identity data. A further object of the invention is to provide a completely automatic identification system which can economically be used by all railroads and freight cars in the country. An additional object of the invention is to provide an automatic system of identification having an inherent high order of reliability.

A further object of the invention is to provide identification means which may be visually inspected and which moreover correspond character by character to the identifying lettering of the car.

[7] Still another object of the invention is to provide an identification system which can be used at interchanges with other railroads to automate car accounting with considerable reduction in clerical labor and errors, and with

fewer delays of cars. A still further object of the invention is to provide a system of identification which can be successfully integrated with current communication facilities such as railroad teletype equipment and associated devices. A still further object of the invention is to provide an identification system which can be used with currently available digital computer equipment with little or no modification. Still another object of the invention is to provide automatic identification to give an up to the minute report on the location of any carload shipment at negligible cost. Another object of the invention is to provide a system which can be used with a hot box detector to identify a bad-order car. A further object of the invention is to provide an identification means for each car which is passive, requiring no further energy sources, and which requires minimal upkeep and infrequent replacement. An additional object of the invention is to provide an identification scheme which in large measure employs components and techniques which have been thoroughly tested and have known operational reliability, operating tolerances, and limitations. Still another object of the invention is to provide an identification system having a primary unit capable of withstanding the rigors of continuous exposure to the weather and to the environment and circumstances in which railroad operations [8] generally occur. An additional object of the invention is to provide identification means which operate entirely independently of the structural material of the car. Another object of the invention is to provide identification means which do not project beyond the existing structure of the car. A further object of the invention is to provide an identification system which is designed to work satisfactorily over any range of car widths and floor heights now in use or known to be proposed. A still further object of the invention is to provide a system which meets the highest standards of safety. Another object of the inven-

tion is to provide an identification system which avoids the use of radio signals and thus will not interfere with other forms of communication.

In the accomplishment of these and other objects of my invention the railway cars or other vehicles to be identified are provided with radiant energy reflective markings. A radiant energy source directs light in this embodiment upon the markings. In the description which follows the directed energy has been sometimes termed interrogating energy. A sensing device is positioned in operative relation with the vehicles so that reflections from the markings, which will be coded for each vehicle, can be sensed thereby.

A feature of the invention is the use of light energy retroflective materials for the coded reflective markings. Retro-reflective material is material which reflects light back close to the same axis as the initiating of incident energy. Retro-reflective light energy is not only positionally or geometrically more easily sensed than specularly reflected light but its concentration also permits better discrimination of the information carrying reflections from ambients in the environment.

[9] Thus the wayside device has one unit which directs a beam of radiant energy on the reflective markings and a second unit, a sensing device, which picks up the coded reflected energy therefrom.

Another feature of this invention is that the coded markings can comprise a series of blocks of grouped vertical strips of retro-reflective material with spaces between. The strips are three different colors, for example, red and green positioned on a white background so that a white strip separates the colored strips. The total number of strips is fixed and an identifying binary code is formed by various patterned combinations of the two colors on white. For example, a red strip could represent "zero" and a green strip could represent "one" in a binary code system.

Each patterned block of six colored strips with white strips between represents a single alpha-numeric character. Ten blocks total, representing ten characters, would be adequate to identify every railroad car in North America allowing four digits for the owner's designation and six digits for the owner's number for the particular car. A further feature of this scheme is the basic simplicity and economy of using reflective sheeting for an energy interrogatable coded system for each railway car. The fact that the markings are passive is another feature of the system.

There is already available retro-reflective material having minute glass beads imbedded in a suitable binder on adhesive sheeting. The code can be preprinted of red and green strips on white sheeting leaving white areas between the strips or separate colored strips may be pasted in suitable patterns. If each block of sheeting represents one character or digit, the white between, responding on both red and green outputs of the radiating sensing system would advance a [10] counter or sequencer for code elements of one character, while the non-reflecting or black surface of the car between characters would count the characters. Marking each digit block a separate piece allows assembling any required vehicle marking from standard pieces and permits placing the pieces in whatever spaces are left by rivet heads, ribs or other protuberances.

The wayside device includes a radiant energy source having an optical system to limit the horizontal width of the radiated energy. Sensing means responsive to the coded reflective energy consists basically of photocells placed close to the same axis as the source of light energy but properly screened therefrom.

The sensing device is coupled to a recording device which can be located remotely. It will include as many recording elements as there are strips sensed on a car, plus a sequence connecting device. The non-reflective spaces between the

strips cause a greatly decreased output from the light responsive circuitry which is arranged in turn to cause the sequence connecting device to advance to the next series of recording elements.

A further feature of the invention is the use of conventional data compilation and storage techniques for the received coded pulses reflected from any particular car. These techniques are versatile, mature, well-advanced, and well-known. The sequence connecting device could be rotary stepping switches or counting chain of relays, or vacuum tubes or transistors. The recording elements could be relays, vacuum tube flip-flops, transistor flip-flops, magnetic cores, [11] or any other convenient digital device. These are arranged to transfer the record of each car to some punched or magnetic medium with enough capacity to record one or more trains. This medium may be remote from the sensing device.

The use of an optical system is another feature of the invention and is preferable to any other system such as magnetic, or electro-magnetic interrogation techniques because of the wide variety of materials used in cars, for example, steel, stainless steel, aluminum, and wood. Moreover, using radio energy can cause interference problems.

Still another feature of the invention is that the use of a light source and retro-reflective coded markings and a reflected light sensing device allows a large tolerance both in vertical, lateral, and longitudinal location of the markings to fit the construction of the different cars and in the location of the sensing device relative to the track. An additional feature of the invention is that the method of sensing is independent of the speed of the cars past the sensing device. A further feature of the invention is that the use of a fixed number of elements is the identification code strip, each of which must be sensed as either one of two colors, provides inherent self-checking. An additional

feature of the invention is that self-checking can be provided if necessary. Yet another of the features of the invention is that the retro-reflective material will provide an additional safety feature, particularly at highway crossings at night. Another feature of the invention is the provision of a standard numeral or letter on the binary character and digit blocks to permit visual as well as automatic identification. This also insures correct placement on the vehicle side. [12] Application of the retro-reflective material to cars is an extremely simple and inexpensive operation. Thus it is another feature of the invention that the application by means of a stencil or fully prepared adhesive sheets insures that the labor cost per car is of the order of magnitude of one or two dollars at the most. Because each block has a numeral or letter thereon equivalent to its binary form, visual selection is greatly facilitated and installation can be performed by unskilled labor. Moreover, periodic inspection requires nothing more than a man who can read and use a flashlight.

Another feature of the invention is that all the components necessary for the sensing device are currently available. Design criteria are well-known and component reliability under the most unfavorable conditions has been thoroughly demonstrated. Still another feature of the invention is the applicability of the resulting coded information in the form of electrical pulses to current teletype relay techniques whether the standard teletype code of five units is employed or the IBM six-unit code.

These and other features of the invention will best be understood with the aid of the accompanying drawings in which:

[13] Fig. 1 is a perspective view of railway cars and an engine bearing coded identification strips with a wayside device mounted in operative relation to the strips;

Fig. 2 is a block diagram of the identification systems;

Fig. 3 shows the arrangement of the coded markings affixed to each railway car;

Fig. 4 is a diagrammatic representation of the optical system of the wayside device taken on a horizontal section;

Fig. 5 is a top view in schematic form of the operational relationship between the wayside device and the vehicle markings with the energy radiation and reflective pattern indicated. Maximum and minimum car widths are also shown;

Fig. 6 is a view of the wayside device in operational relationship with the coded vehicle markings viewed along the vehicle axis. Maximum and minimum car widths and maximum and minimum car heights are also indicated;

Fig. 7 is a general schematic arrangement of the signed inputs to the storage system showing logic, bit counter-recorder, digit counters, read-out converters, and matrix of memory elements;

Fig. 8 is a block schematic arrangement of the initial portion of a bit counter and associated logic;

Fig. 9 is a block schematic of a typical element in a memory device;

Fig. 10 shows a block schematic of the final portion of a bit recorder;

Fig. 11 is a diagrammatic representation of an alternative light source.

[14] I. *EQUIPMENT GENERALLY*

The preferred embodiment of my invention herein described is shown in blocks in Fig. 2 and comprises the combination of binary coded retro-reflective markings 20 affixed to each of the vehicles to be identified, and a wayside device 22 mounted near the track side to function in operational relationship with the coded markings 20. The wayside device 22 consists of two separate units, an interrogating unit 24 which shines or directs a vertical, narrow beam of radiant energy (light) upon the markings 20 and a sensing unit 26 which is responsive to the energy reflected from

the markings. From the sensing unit 26 electrical signals corresponding to the code pattern of reflected energy are fed to appropriate computer logic 28 the output of which is in turn fed to a computer storage unit 03 or local memory 32, and there to various read-out devices 34 and 36. For remotely located equipment, a transmission facility 38 is made part of the system.

II. *OPERATION GENERALLY*

Each railway vehicle 40 has affixed to its side an identification code made up of ten patterned blocks 42 of retro-reflective material. Each such block consists of retro-reflective strips 44 of two colors alternating with a strip of white reflective material between the colors. The wayside device 22 is positioned in respect to the track side so that light energy from the interrogating unit 24 is directed at the reflective blocks 42 which are arranged in an identification code. The sensing unit 26 is positioned to selectively respond to the three values of reflected light energy, two different colors and white, caused by light emitted from [15] interrogating unit 24 being reflected from the strips 44 which make up the blocks 42. The sensing unit 26 distinguishes each of the two colors and white, changing the reflected energy into corresponding electrical pulses. The pattern for each block 42 is made of the two colors with white between and represents in digital or binary notation a particular letter or number character. The computer logic 28 assembles the electrical pulses, each of which corresponds to a binary digit (bit), into a collection of six bits forming a letter or number character and then collect the ten characters which form the coded designation of the particular vehicle. The designation is fed to the storage unit 30 and on local memory device 32 to be retained at least long enough for any single train of cars 40 to pass. The information stored can either be permanently recorded on IBM cards or tape, transmitted to a remote location, printed in alphanumeric

form or temporarily presented, for example, on a lighted board. Alternatively, the logic-recording system 28 and 30 might be arranged and programmed so that cars of any particular code designation having been interrogated and sensed would initiate a series of directions addressed to some other computer program.

III. *CODED MARKINGS*

As shown in Fig. 1 each car 40 would have affixed to the side thereof ten blocks 42 of the coded markings 20. An individual block 42 is shown in Fig. 3. Each block is about 2″ x 5″, and is composed of six colored strips 44 of retro-reflective material, with what is in effect a white strip between each colored strip forming a pattern which can be arranged in sixty-four permutations. The patterns can be [16] fabricated by printing the particular color pattern thereon or might be fabricated more conveniently by using a sheet of white retro-reflective material on which the color strips 44 are applied.

The code pattern on each block 42 is made digital by having one of the colored strips 44 represent binary "zero", the strip of the other color representing binary "one". Each of the ten blocks 42 can thereby represent in digital form an alphabetical or numerical character. Thus, in the simplest binary notation, a block 42 having, for example, red and green representing "one" and red "zero", a left to right pattern (ignoring the white strips in between) of red-green-red-red-red-red-would indicate the number two and a pattern of strips red-green-green-red-red-red- would correspond in binary form to the number 6 as shown in Fig. 3. A combination of ten blocks 42 are sufficient to give an identification designation for all the railroad cars in North America using four blocks for the owner's alphabetic code and the remaining six for the numerals.

While the colors green and red have been chosen for purpose of this preferred embodiment it should be pointed

out that the particular colors are unimportant so long as they are sufficiently different. The two colors chosen should be selected to be spectrally quite distinct and distinguishable. There is no reason, of course, why the two different strips could not be distinguishable by video sensing means and yet undifferentiatable by the human eye. Also, different strips having different polarizing characteristics could be employed. Yet it would seem to be an advantage to use visually distinct colors and thus permit ready non-automatic observation that the correct blocks are properly arranged.

[17] An individual element of convenience is providing each code block 42 with the equivalent actual number or letter printed thereon. A further advantage of visible red and green strips is that the markings would serve as an added safety measure.

For the markings the material "Schotchlite" is available. It is a flexible sheeting with retro-reflective glass beads on the face and pressure-sensitive adhesive on the back, obtainable in white and colors. Transparent inks are available for printing or stenciling. It is more easily applied and is presently more efficient optically than any available retro-reflective paint.

IV. *WAYSIDE DEVICE*

The wayside device 22 consists of two closely situated but distinct units, the interrogating unit 24, and the sensing unit 26. The interrogating unit 24 is basically a light source which directs at the sides of passing railroad vehicles 40 a horizontally narrow band of radiant light energy 40 having a considerable angular dimension in the vertical plane. As each railroad car 40 moves past the band of light energy 46, the various coded data patterns of green, white and red strips 44 on the blocks 42 affixed to the sides of the cars will reflect light of different color values to which the sensing unit 26 will respond.

The light source 24 concentrates its output on an area a foot high and less than half an inch wide at a distance of 3′0″ to 3′6″ from the projector. The sensing unit 26 must pick up the retro-reflected light as close as possible to the source projector 24 and separates red and green components onto two light responsive means. The light projected onto the markings 20 must be bright enough that the retro-reflected component reaching the sensing unit 26 is markedly stronger than the brightest diffused reflection of sunlight or any [18] other ambient light. Power limitations at a remote location and signal-to-noise ratio in the sensed information require that optical efficiency be maximized.

A. *INTERROGATING UNIT*

In Fig. 4 there is shown in horizontal section a detail of radiant energy source or interrogating unit 24. A light source 48 which is a point or vertical line of light is located near the rear focus 50 of a substantially elliptical reflector section 52 in such a way as to concentrate light at a focal point 54 some distance from the focus. The reflector 52 could also have a semi-cyclindrical shape, or any configuration capable of focusing a vertical line of light. In front of the focal point 54 is a combined transmitting lens and prism 56 for projecting the light in a beam essentially parallel in horizontal cross section; the focus 54 of this lens and prism 56 is also the front focus 54 of the elliptical reflector 52.

B. *SENSING UNIT*

The narrow vertical band of light 46 played on the coded blocks 42 causes light 70 of various spectra to be reflected back to the sensing unit 26. The latter is located roughly on a common vertical axis with the interrogating light source unit 24. Since the reflections are parallel to the initiating stimuli, a receiving lens 58 similar to the transmitting lens 56 focuses the retro-reflected energy. A vertical slit 60 is provided near the focus 62 of the receiving lens 58 to limit accepted light to a region narrower than the image of any

given strip 44. Immediately behind the slit 60 and located at a diagonal thereto is a dichroic mirror 64. A dichroic mirror is one which will transmit one color [19] but will reflect another. A light sensing device 66 for the transmitted color is located behind the dichroic mirror and a light sensing device 68 for the reflected color is located at an angle thereto.

Indicated diagrammatically in Figs. 5 and 6 is the operation of the interrogating beam of light 46 upon the coded markings 42 and the effect of various car widths and floor heights. Thus in Fig. 5, the horizontally narrow light beam 46 represented by parallel double lines with arrows is directed at car sides of a maximum width car 72 and minimum width car 74. Retro-reflected energy 70 represented by two parallel solid lines with arrows in the opposite direction is returned to the sensing unit 26 along the same axis as the interrogating beam 46. Light reflected specularly from the markings is represented by the dashed lines 76. A shield 78 is provided to prevent interfering light from being reflected specularly to the sensing device.

A side view of the interrogating light beam 46 in Fig. 6 indicates the manner in which the vertically spreading light energy can accommodate markings on the widest car 72 with a considerable difference between the lowest 80 and highest 87 car floors where the blocks 42 can be affixed. Fig. 6 also shows a narrow car 74 with low 80 and high 82 floors. The vertically wide angular configuration of the light beam 46 thus permits interrogation irrespective of either the floor height or the width of any vehicle 40.

[20] C. *LOGIC*

It should be noted that the logical units shown here are not necessarily the simplest that will accomplish the purpose, nor is the operating sequence necessarily the only one. The units and sequence here described demonstrate however, the practicability of the whole system. In fact, there are

many devices already available commercially which with only a slight amount of modification could perform the sequence outlined below or at least give the same described result.

As the cars 40 move past the light beam 46, the various strips 44 on any car will reflect light of different color or spectral values, greens, red and white. The light sensitive devices 66 and 68 either separately or simultaneously (in the case of white reflected light) convert the reflected energy into electrical pulses. The absence of reflected light also has operative significance and thus can be considered as a fourth electrical input pulse.

The general operation of the sensing logic can be explained with particular reference to the block diagram shown in Fig. 7. The two sensing inputs R and G stand for red and green and are equivalent respectively to 0 and 1 coresponding to the different energy values reflected from the identification code. The logic elements in block 84 determine whether one signal is present or both or neither. The four possible inputs consist of red present-green absent (RG), red absent-green present (RG), red and green both present (RG), or neither (RG), all of which are fed into a bit counter-recorder 86. When (RG) occurs one is recorded, when (RG) occurs "zero" is recorded. When both red and green 30 are present (RG) the bit counter 86 is advanced and when neither red or green is present (RG) the counter is reset.

[21] The six leads, 88, 90, 92, 94, 96, and 98, from the bit counter-recorder 86 represent as many successive output paths as there are bits in a digit or character, in this case six bits. After the first bit is recorded through the first output, an "advance bit counter" signal caused by reflection from a white strip will transfer it to the second output, then to third, fourth, fifth and sixth, as each bit is recorded. But before the first is recorded the "advance bit counter"

signal will have no effect. A reset signal before the last bit is recorded will cause the "imperfect digit" code to be submitted for whatever has been recorded.

A digit counter 100 will have as many outputs 102-120 as there are digits. The schematic intersection of an output from the digit counter 100 and one from the bit counter 86 is the location at which the "1" or "0" of one bit is recorded. This recording location could be a magnetic core, flip-flop or any other one bit device. In summary, the schematic operation is to record each digit of six bits in a horizontal row a bit at a time, then advance vertically to the next row for the next digit.

The "form car detector" input is either from some separate device such as a strain gauge on the track or it could be a special extra digit code such as all zeros, that is a code pattern block 42 of red-red-red-red-red-red, would come from the bit counter 86. This input will cause the record of one vehicle to read out into whatever recording medium or transmission line is to utilize the information. For this purpose, the digit counter 100 will rest, read-out a digit, advance, read-out the next digit and finally rest after the last digit and stand for the next vehicle.

[22] Referring to Fig. 8, marking information is sensed as follows: Color R along RG represents informational "O"; and "and gate" receiving RG puts out an electrical "one" to indicate this on the line labeled "O". Color G alone RG represents informational "1"; the "and gate" receiving RG puts out an electrical "one" on the line labeled "1". Both together RG, i.e. white, serve to switch between bits; the "and gate" receiving RG puts out an electrical "one" on the line labeled "T" for transfer. Absence of both RG (no reflection) serves to switch between digits of characters; the gate receiving RG puts out an electrical "one" on the line labeled "Re" for reset.

Initially all bit counter flip-flops 122, 126, 130 and so forth are reset (Re) and all memory elements are zero or rest. In this condition a white or "t" signal will have no effect. Either a "1" or a "O" signal will set the first flip-flop through the "or gate". If it is a "1", the first flip-flop set and the second reset will allow it to pass the "and gate" 132 below to the "record one first bit" line 134.

The first flip-flop 122 set opens an "and gate" 124 over a second flip-flop 126 to allow a T signal to set it. This in turn opens an "and gate" 128 over a further flip-flop 130 and allows either a "1" or "O" signal to set it and also closes an "and gate" 132 to the "record one first bit" line 134. If the second bit is a 1 it passes an "and gate" 136 to "record one second bit" 138. Successive bits operate the successive flip-flops in the same way until the last flip-flop 140 is reached or a Re signal is received (Fig. 10.)

[23] A Re signal with the last flip-flop 140 still reset through gates 141 and 145 or a T signal with the last flip-flop set through gates 143 and 145 operates the "imperfect digit recorder" 142 to substitute the symbol for an imperfect digit for whatever has recorded since the last reset.

A "1" signal at any time during a digit sets an auxiliary flip-flop 144 indicated in Fig. 10. When this remains reset as the last regular flip-flop 140 is set it indicates an all zero code that marks the end of one vehicle identification and opens a gate 146 to the "to read-out" line. If the auxiliary flip-flop 144 and the last regular flip-flop 140 are set, and Re signal resets all flip-flops. But if the read-out operates, its return signal resets all flip-flops. The imperfect digit recorder 142 also resets all flip-flops. Resetting all flip-flops also advances the digit counter 100 to advance to the next digit in the memory. A typical memory element is shown in Fig. 9.

Another approach to the same logical performance is by use of "shift registers". A shift register is an assemblage

of memory elements so arranged that when a "shift" signal is applied the entire information content is shifted one step and the element that records the input is made available for the next input information. In other words the input information is recorded at a single point and then transferred rather than the input connection being transferred and the information remaining at a fixed location.

For this application a full use of shift principal would involve a "two-dimensional" shift; i.e. successive bits would shift down a line to form a digit then entire digits would shift in a second direction down an assemblage to form a multi-digit indentification code.

[24] Other variations of the invention will be apparent to those skilled in this art. For example, in some applications or circumstances it might be more effective to pulse the light source at a frequency of a few thousand cycles and employ an appropriate pulse discrimination function in the sensing operation. Regular light pulses are considerably more distinguishable from random ambients than a steady directed beam in troublesome milieu.

Fig. 11 shows an alternative form of the optical system shown in Fig. 4. Light source 48A with a vertical line filament at the rear focus 50 of elliptic mirror 52 causes a vertical line of light to concentrate at the front focus 54, at which limiting slit 200 is located. Field lens 202 concentrates the light emerging from slit 200 in a narrow beam. This beam passes through projection objective lens 204 which focuses the light into a concentrated narrow line on the markings 20 of the vehicle 40 to be identified. Lens 204 must have good definition and color correction to form the desired narrow line.

The retro-reflective light from the markings 20 falls on the entire surface of the lens 204. Light on either side of the narrow source beam falls on dichroic mirror 64, from which one color is transmitted to light sensitive elements

66 and the other color is reflected to light sensitive elements 68. Shields 206 prevent stray light from the sources from reaching the light sensitive elements 66 and 68.

High frequency modulation of the light may be produced by vibrating the sides of slit 200 electromagnetically.

Since still other variations of the preferred embodiment of the invention will occur to those skilled in the art, it is not intended to confine the invention to the precise form herein shown, but to limit it in terms of the appended claims.

I CLAIM:

For Claims 1, 2 and 3, see Rejected Claims 1, 2 and 3.

Rejected Claims

1. A coded light-reflective marker for use in a railroad car identification system of the type adapted to identify individual cars bearing said markers and moving sequentially along a predetermined path, said system including means for scanning said cars and said markers with a beam of light having a frequency spectrum including at least two distinct and distinguishable frequency bands of light together with optical means for projecting said beam from a source which is substantially a point to discrete portions of said markers at an angle of incidence substantially divergent from normal to the plane of said markers and for receiving light retro-reflected from said portions of said markers at a point as close as possible to said source; said markers comprising: elongated strips of retro-reflective material comprising a multiplicity of small, closely spaced retro-reflective lens systems, imbedded in said strips and distributed across the full length and width thereof, each said system including means for retro-reflecting incident light, concentrating same back along, and

close to, the same axis as that of the incident light where said axis is at an angle substantially divergent from normal to the plane of said strip, said strips arranged in segmented permutatively patterned areas adapted for variously (a) retro-reflecting, from substantially all areas of their length and width, each said band individually, (b) so retro-reflecting at least two said bands simultaneously, and (c) not retro-reflecting any of said bands.

2. A coded light reflective marker as claimed in claim 1 wherein said segmented areas are arranged in a predetermined coded pattern.

[75] 3. A coded light reflective marker as claimed in claim 2 wherein said segmented areas are a plurality of parrallel elongated strips of retro-reflective material, and of effectively non-retro-reflective material.

4. A coded light reflective marker as claimed in claim 3 wherein said strips of effectively retro-reflective material are selectd from strips which are retro-reflective of two colors individually and from strips which are retro-reflective of both said colors simultaneously, and said strips of effectively non-retro-reflective material are selected from strips which are not retro-reflective of either of said colors, and wherein the code is based on the sequential arrangement of said strips according to whether neither nor either band or both bands of light are retro-reflective therefrom.

5. A light-reflective marker for an identification system adapted to give positive identification of individual railroad cars moving sequentially along a predetermined path such system including an interrogating unit located at a fixed position alongside said path, said interrogating unit including a light source adapted to emit a beam of light having a broad frequency spectrum and including at least two spectrally distinct and distinguishable frequency bands of light in a narrow oriented beam intercepting the path of travel of said cars and a sensing unit located at a fixed

position alongside said path in close association with said interrogating unit, said sensing unit adapted to receive light emitted from said interrogating unit when reflected from a said such reflective marker and to detect separately said band of light in said reflected light, said such light reflecting marker positioned on each moving car in position to intercept said beam of light, each said marker formed of a plurality of elongated strips of retro-reflective material comprising a multiplicity of small [76] closely spaced retro-reflective lens systems inbedded in said strips and distributed across the full length and width thereof, said strips adapted to reflect light substantially along the same axis as the axis of light incident thereon, said strips being arranged as to be successively illuminated by said beam, the material in said strips selected from retro-reflective material having reflection-absorption characteristics of a plurality of types, said types retro-reflecting variously, from substantially all areas of their length and width, each of said bands while absorbing the other of said bands and so retro-reflecting a plurality of said bands simultaneously, said strips arranged by type in a predetermined code pattern.

6. A coded light reflective marker as claimed in claim 2 wherein said pattern includes (a) at least one sub-pattern which is a coded designation of a particular alphanumeric character and (b) legible indicia in standard alphanumeric form corresponding thereto associated with said sub-pattern.

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CHECKING SYSTEMS

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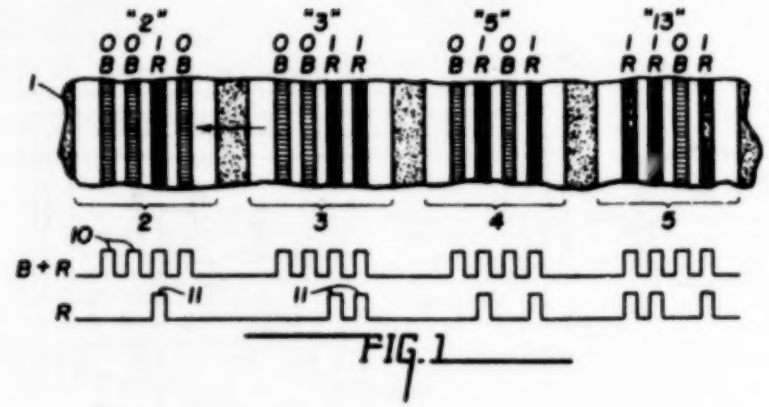

FIG. 1

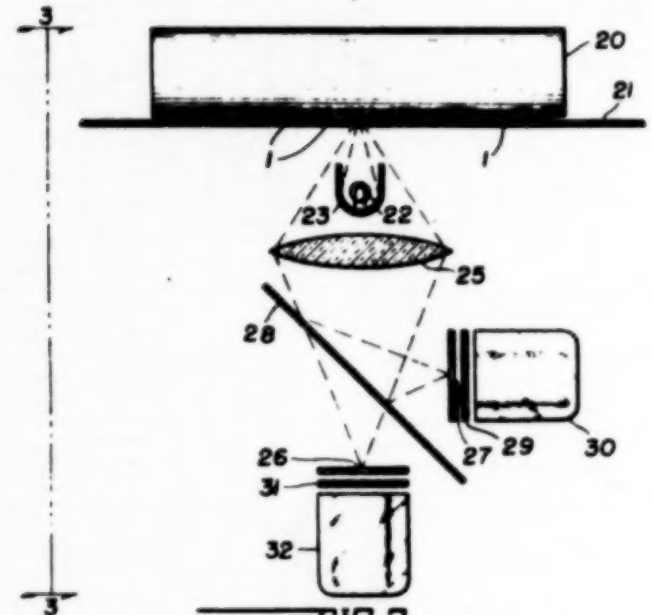

FIG. 2

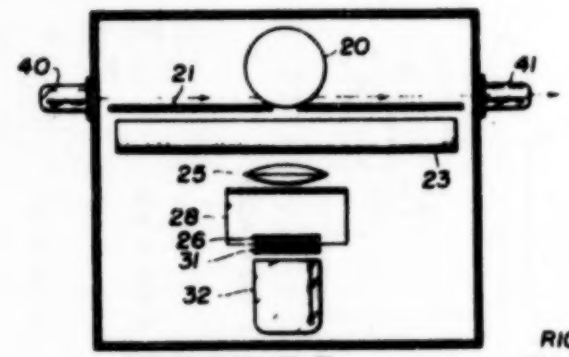

FIG. 3

INVENTOR
RICHARD K. ORTHUBER
BY
George A. Smith
ATTORNEY

Aug. 11, 1959 R. K. ORTHUBER 2,899,132
CHECKING SYSTEMS
Filed Dec. 30, 1955 2 Sheets-Sheet 2

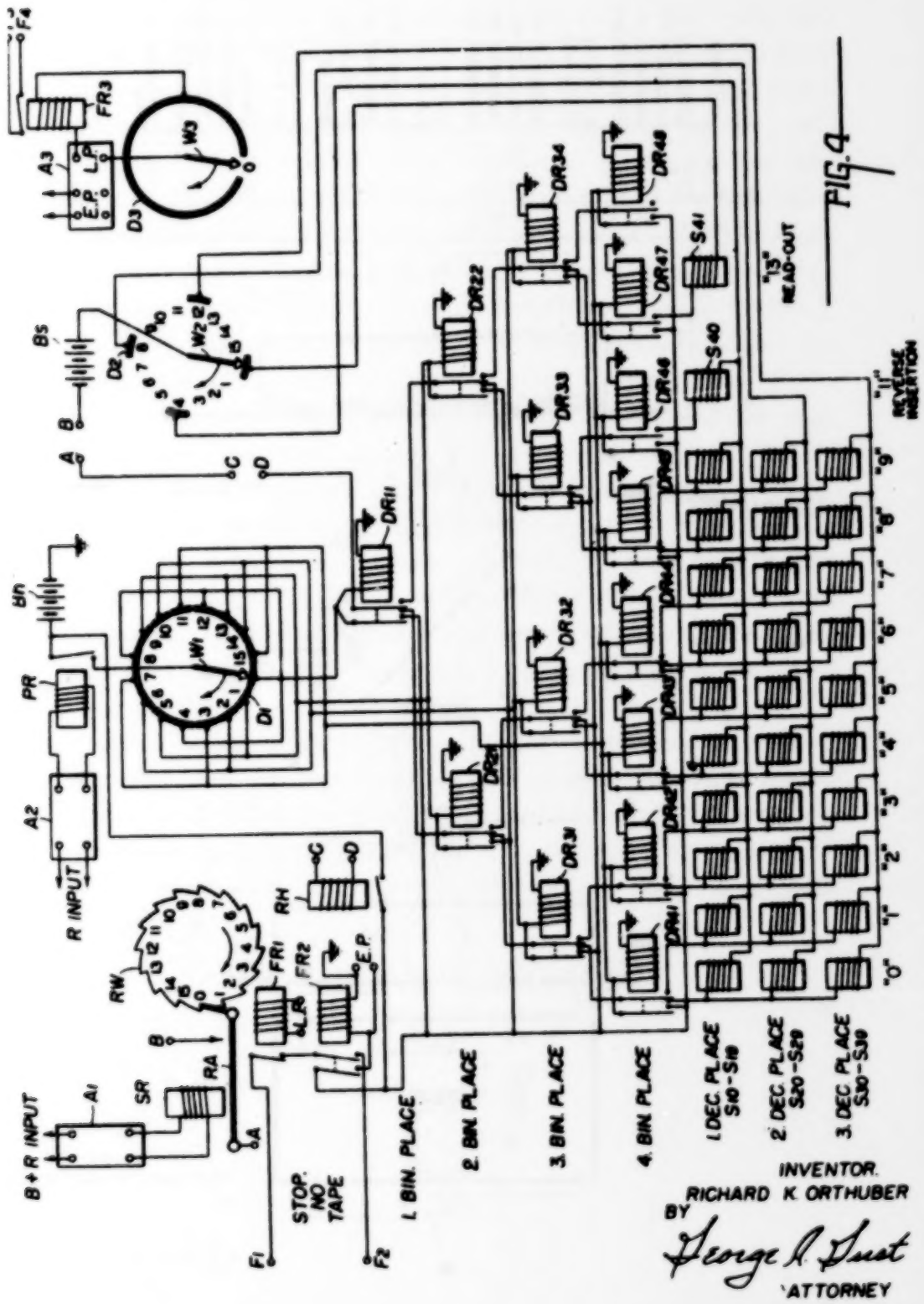

FIG. 4

INVENTOR.
RICHARD K. ORTHUBER
BY George R. Dust
ATTORNEY

United States Patent Office 2,899,132 Patented Aug. 11, 1959

2,899,132

CHECKING SYSTEMS

Richard Kaspar Orthuber, Fort Wayne, Ind., assignor to International Telephone and Telegraph Corporation

Application December 30, 1955, Serial No. 556,687

14 Claims. (Cl. 235—61.6)

This invention relates to checking systems and is particularly directed to means for automatically tabulating and summing prices, numbers of, or other information on large quantities of packages of regular and irregular shapes as in retail merchandise handling.

The present practice in handling merchandise in retail markets and the like consists of an operator handling each package, noting the information on price tags, and transferring such information to a cash register or other recording equipment. In grocery handling such procedures are time-consuming and costly. Efforts to facilitate handling and bundling are only partially effective.

While this invention is specifically discussed and described in connection with handling retail merchandise, it is to be understood that the principles are applicable to any line of endeavor wherein it is desired to distinguish between mixed articles.

The object of this invention is a machine for inspecting pieces of merchandise or packages, and recording or tabulating the information marked on the merchandise, without the aid of human operators.

The objects of this invention are attained by placing groups of stripes on the packages, the stripes having two distinctive colors. A conveyor is provided for carrying the stripes of the packages laterally across two photocells which have optical means for admitting to the cells only light corresponding to said two colors. A counter is coupled to the photocells for converting the binary information contained in the pulses at the output of the photocells into decimal numbers, which decimal numbers may then be employed for operating a display or cash register.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a plan view of a section of a package having color coded tapes according to this invention;

Fig. 2 is a sectional view of one photocell inspecting mechanism of this invention;

Fig. 3 is a sectional view of the apparatus of Fig. 2 taken on line 3—3 of Fig. 2; and

Fig. 4 is a circuit diagram of one binary to decimal converter of this invention.

The first step in marking a package, handled in the marketplace, for reliably labelling the article for automatic inspection comprises, according to this invention, placing marks on the package which will yield reliable binary information. It is to be realized that in the binary number system of "0" and "1," the "0" does not correspond to absence of information. For a reliable inspecting system, the "0" of the number system must be evidenced by positive information, and the "1" evidenced by other and distinct positive information. It is proposed according to this invention to place colored stripes of two distinct colors on the packages to be inspected. It is proposed to arrange the stripes in a plurality of groups, the stripes in each group being arranged so that when read or scanned laterally across the stripes, the stripes represent binary numbers. Hence the groups may be arranged in succession to correspond in position to successively significant decimal numbers.

In Fig. 1, for example, the package surface 1 is painted or coded with groups of stripes 2, 3, 4, and 5, the stripes in each group being parallel and spaced apart. Each group of stripes may be printed on the package or onto individual tapes 2, 3, 4, and 5. Preferably, the spacing between the groups is greater than the spacing between the stripes of the groups, so that the reading mechanism, to be described, can distinguish between groups. A strip of tape 1 is attached to each package or article to be handled in the merchandising operation, or, alternatively, the stripes may be painted or stamped directly on the surface of the article or its container. The paper tape is so attached to the article that as the article moves on the conveyor of the machine for inspecting the article, the stripes are disposed perpendicularly to the direction of travel. Hence, any photo-electric means for scanning the article will see alternately stripes of either of two colors and blanks.

Let it be assumed that an article is to be labelled with a price of $2.35. Group 2 of stripes must be coded to represent the decimal number "2," in which case the four stripes of group 2 reading from left to right would yield 0010. Any combination of 0's and 1's within the sixteen possible combinations all four binary bits could, of course, be chosen to represent the desired numeral "2." Likewise, the numbers "3" and "5" of $2.35 can be reliably written on the tape by the color coded stripes in groups 3 and 4. The stripes may be of two colors of widely spaced spectral characteristics. The wavelength of red and blue for the stripe colors may be one choice of colors, inasumch as commercial photocells and light filters readily distinguish between these two colors.

In the interest of reliable "reading," it is desirable to scan the tape with one photocell which will respond to either of the two colors, while another photocell will respond to one only of the two colors. According to an important feature of this invention it is relatively simple to illuminate the tape with high level white light and shield the photocells with proper light filters so as to operate the photocells by the stripe-colors, provided that no other markings or optical patterns are present on the articles or packages to disturb the reading of the color-code. In the assumed example, the output of one photocell will yield a distinct direct current pulse 10 as shown in Fig. 1 for each stripe scanned, regardless of the color of the stripe. From the other photocell, pulses 11 are produced and, as will be shown, pulses 10 and 11 when combined in a counter of this invention will reliably register the zeros (0's) and ones (1's) of binary numbers.

The problem of applying price markings in such a way that a reading device can distinguish the price markings from the various color patterns appearing on commercial packages will now be considered. According to this invention, the color stripes used for price markings on the package or on the tape may be made by an ink in which the conventional pigments are replaced by a powder which, under the influence of ultraviolet illumination, luminesce in the visible or invisible range of the spectrum. In place of the previously discussed red and blue stripes, there will therefore be two different kinds of stripes which luminesce in two different spectral ranges when irradiated by ultraviolet light. There are a large variety of phosphor materials available which luminesce in various spectral regions and may be used as pigments for printing two distinctly different types of color stripes. Though the luminescence of those stripes under ultraviolet illumination may not exactly be "red" and "blue," they

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generally may be only spectrally different. For convenience, however, "red" and "blue" will be hereinafter referred to. While there are many phosphors which have the desired spectral characteristics, mention is made of two. For the blue phosphorescence, hexagonal zinc sulphide, activated with .01% silver, may be used, and for the red phosphorescence zinc or cadmium sulphide activated with a .005% copper may be used. The reading of such stripes painted either directly on the package or article or on tapes glued to the article can then be carried out by conveying the package containing the fluorescent marks through a dark space or a space with reduced visible illumination, and illuminating the marks by an ultraviolet light source. The lower the ambient light level, the greater will be the signal-to-noise ratio at the output of the photocells. It is preferred, of course, that no visible light be reflected from the package surface, with the exception of the fluorescent light, even though patterns on the package may be of brightly colored inks or paints.

There are innumerable phosphors out of which the distinctive colors of the stripes may be made. The spectral characteristics of the phosphorescent material selected should be matched as closely as possible with the characteristics of the photocells. The light-reflecting characteristics of the stripes and their distinctiveness against the tape background will, of course, depend upon the level of daylight, fluorescent or incandescent light in the background. If the photocell inspecting is done at reduced ambient illumination, as under a hood, the requirements of contrast as between the stripes and between the stripes and the background are less severe.

One mechanism for inspecting the coded packages according to this invention is shown in Fig. 2, where the package **20** to be inspected is moved from left to right on the conveyor belt **21**. With the particular mechanism of Fig. 2, it is assumed the tape **1** with its colored stripes is attached to the bottom of the package and that the inspecting is done from the underside thereof. The light source **22** in a light-tight house (not shown) and a reflector **23** illuminates a spot on or the stripes across the bottom side of the package **20**. The conveyor belt may be of transparent plastic, for example, or may have lengthwise slot to expose the underside of the package to the light source. Reflected light from the package is gathered by a lens system, such as the concave-concave lens **25**, and focused upon aperture **26** as well as aperture **27** of two light gates. Inclined mirror **28** is of the type which will reflect approximately 50% of the light from lens **25** to aperture **27** while transmitting the other 50% to aperture **26**. Alternatively, prisms could be used to divide the reflected light and illuminate the two gates **26** and **27**. Light filter **29** is preferably placed on one side of the plate of aperture **27** to admit to the photocell **30** light of the wavelength of one stripe. Filter **31** is placed over photocell **32** so that light of other spectral characteristics is admitted to cell **32**. The filter characteristics of filters **29** and **31** are so chosen with respect to the spectral characteristics of the photocells **30** and **32** as to accentuate the light selectivity of the two photocells. Pursuing the example mentioned in Fig. 1, one of the filters **29** would be selected to admit red and blue light or in the alternative could be omitted, while filter **31** would be selected to admit red light only.

There are two principal causes of error in the inspecting system contemplated in Fig. 2. First, failure may be caused by partial or total loss of the coded tapes **1** from the package. Secondly, the package may be reversed so that as it passes over the reader the binary information is read in reverse. To obviate errors due to loss of price tape codes or attempts at "smuggling," a light gate is provided as shown in Fig. 3 where a source of light **40** and a photocell **41** are aligned on opposite sides of the path the package must travel so that a positive indication is obtained upon the entry of a package to the reader. The output of photocell **41** is interrelated, in the counting mechanism, with the outputs of cells **30** and **32**, as will be more fully described hereinafter.

To obviate errors caused by reverse reading, an additional group **5** of stripes (Fig. 1) is added to the tape **1**. The fourth group is placed to normally follow the three preceding groups of stripes through the reader. If the binary code for the price information of each group includes all numbers from 0 to 9, the reverse-reading binary number selected for group **5** should consist of a binary number such as 11 or 13, neither of which when read in reverse can be found in the 0 to 9 binary numbers. The particular code arbitrarily assigned to group **5** in Fig. 1 is the number 13, which if read in reverse will initiate a visible or audible alarm. Conversely, when group **5** is read in proper sequence, after groups **2**, **3** and **4**, the number 13 may operate a read-out relay, to be described, for converting the binary information to decimal information and readying the machine for the next inspection.

Fig. **4** shows an example of a counter or decoder which is capable of interpreting the type of pulse information of Fig. 1. The circuitry shown is adapted to convert the binary information received from photocells **30** and **31** into decimal digits of three significant places and to close circuits corresponding to the keyboard circuits of an adding machine. In addition, the circuits operate an alarm as well as a circuit for stopping the conveyor belt when the price code tapes are damaged or missing or when the tape moves through the reader in the reverse direction. All of the circuits of Fig. 4 are in the "at rest" condition which prevails just before a package enters the reading zone. The circuits are adapted to receive the information of Fig. 1 in which one photocell accepts both "red" and "blue" pulses and the other photocell accepts red pulses only.

Amplifiers A–1 and A–2 are coupled respectively to photocells **30** and **32**, while the differentiating amplifier A–3 is coupled to photo-tube **41** and is adapted to produce at output terminals "EP" an "entrance pulse" when the light gate **40**—**41** (Fig. 3) is interrupted. The differentiating amplifier A–3 will produce a "leaving pulse" at terminals "LP" when the light circuit at **40**—**41**, Fig. 3, is reestablished. There are innumerable differentiating circuits which will produce a pulse when a sudden change of voltage occurs as at the output of photo-tube **41**.

The output of amplifier A–1 energizes solenoid SR so that by means of the ratchet armature RA, the 16-tooth ratchet wheel RW is advanced one step for each pulse picked up by the *B+R* photocell. Ratchet wheel RW is keyed to a shaft to which are keyed contact wipers W_1, W_2 and W_3, so that each of the wipers travels sixteen steps per revolution. Each wiper moves over segments of commutators or distributors D_1, D_2 and D_3 respectively. Distributor ring D_1 contains 16 separate segments so that wiper W_1 always makes contact with one of the segments. In the rest position wiper W_1 rides the contact 0.

Distributor D_2 contains only four contacts arranged so that wiper W_2 makes contact with segment 0 in the rest position and with contacts at positions 4, 8 and 12 of the ratchet wheel. Finally, distributor D_3 consists of a ring with a gap at position 0 only. Arranged beneath the distributors of Fig. 4 is shown a group of relays which perform the function of decoding the binary signals picked up by the photocells. These relays are arranged in four horizontal rows, the first row containing one relay DR_{11}, the second row containing relays DR_{21} and DR_{22}, the third row containing four relays, and the fourth row containing eight relays as shown.

The first, second, third and fourth rows of the decoding relays DR have their solenoids connected to the pulse relay PR, in the output of amplifier A_3, through the wiper of distributor D_1. At least one decoding relay in each row comprises two mechanically coupled armatures,

which in case of interruption of solenoid current return to their rest position, or left-hand position of Fig. 4. One of the armatures, at the right in Fig. 4, makes contact with excited as well as unexcited solenoids. The armature may be termed the decoding armature, since if no R or "red" pulse is received it stays in its left position corresponding to a binary "0." If an R pulse is received, the decoding armature closes on the right contact corresponding to a binary "1." If this position is assumed, the second or holding armature will also make contact and close the solenoids of all the decoding relays of a given row to the terminal of the holding battery B_h, provided, however, the holding release relay RH is closed.

Since all ungrounded terminals of the decoding solenoids in each row are connected, it is not necessary that each relay contain a holding armature and contact as shown. It is only necessary that one relay in each horizontal row contain a holding contact.

Across the bottom of Fig. 4 are three horizontal rows of solenoids S_{10}–S_{19}, S_{20}–S_{29}, and S_{30}–S_{39}. These solenoids are adapted to punch the keys of a cash register or to close circuits (not shown) corresponding to the cash register keys. The first horizontal row of the punch-solenoids shall engage with the first vertical column of keys on the cash register keyboard which corresponds in the assumed example to the number of dollars. The second horizontal solenoid row is aligned with the keys corresponding to the number of dimes, and the third row is aligned with the keys corresponding to the number of pennies.

In addition, the first decimal place row contains the solenoid S_{40}, which operates when an "11" is read out of the binary information received from the tape and which may operate an alarm to indicate reverse insertion of the package. Solenoid S_{41}, also in the first horizontal row, is energized when the binary code "13" is received and which operates the read-out key of the cash register. The remaining circuits of Fig. 4 will become apparent in the following chronological description of a reading cycle of the assumed coded price $2.35. The first three steps on tape **1** of Fig. 1 contain the binary information corresponding to $2.35, the fourth group of stripes corresponding to the binary number "13." The sequences of pulses **10** and **11** of Fig. 1 are fed respectively into relays A_1 and A_2. The first event in the approach of a package toward the reader will be an interruption of the gate beam of photocell **41** (Fig. 3), and production of an entrance pulse at terminals EP by the differentiating amplifier A_3. This will close the contacts of both armatures of the failure relay FR_2, which connects the solenoid of FR_2 to the holding battery B_h and thus keeps both contacts of FR_2 closed as long as the hold-release relay RH is not energized.

The first code pulse received in the example assumed is a "blue" pulse, which energizes only amplifier A_1 and moves ratchet wheel RW one step. With the decoding relays in rest position, the point A is connected through the first decoding relay of each row to the upper terminals of the punch relay solenoids. For "0" the lower terminals of the punch relay solenoids are disconnected, however, by the position of wiper W_2 so that no punch-relay solenoid is energized. It follows that the only consequence of the first blue pulse is the advance of all wipers W_1, W_2 and W_3 by one step.

The second pulse is also a blue pulse, so that amplifier A_2 and its connected relay PR remains inactive and the wipers advance a second step.

The third pulse, however, is a "red" pulse and both amplifiers A_1 and A_2 and their connected relays are energized. It shall be assumed that the pulse relay PR and all decoding relays DR are considerably faster in response than the ratchet wheel. Alternatively, one of the photocells may be shifted slightly in the optical system of Fig. 2 and the same light signal is picked up somewhat earlier by the "R" photocell than by the "*B+R*" photocell. This means that the third pulse in the example will close the contacts of relay PR before the wipers W_1 and W_2 have time to move to position 3. The solenoids of the third row of the decoding relays are then connected to segment 2 of distributor D_1 and are energized by battery B_h. Due to the simultaneous establishment of a holding contact, the decoding armatures of the third row are held in their right-hand position after the contacts of PR are opened. This decoding step must be finished before wiper W_1 has left the segment 2 of distributor D_1.

The fourth pulse in the example is a "B" pulse again, and finally determines the first decimal digit of the price. Again relay PR is not energized and the decoding relays of the fourth row remain at rest. All wipers advance from segment 3 to segment 4 and during the second half of this advancement contact is established between the segment 4 of distributor D_2 and wiper W_2, thus connecting the lower terminals of all punch-relays (of the first decimal row) to one terminal of battery B_s. Shortly before this advance is completed, the ratchet armature completes the contact A—B and the solenoid for the decimal digit 2 is energized by battery B_s.

Simultaneously with the energizing of any punch solenoid S, the hold-release relay RH is energized. This relay shall be of the delayed action type, so that its contacts are broken only after the punch solenoid has performed its function to set the cash register key associated with it. The delayed interruption of the RH contact will then de-energize the solenoids of the decoder relays DR so that all of the DR relays return to their left or rest position. In addition, the holding circuit of the failure relay FR_2 is interrupted so that its contact which was previously closed by the light gate entrance pulse is now broken. Hence after four steps of the ratchet wheel the decoding of the first decimal place digit is completed. The second decimal place is read similarly, wiper W_2 proceeding from position 5 to position 8. While the third decimal place information is decoded, W_2 proceeds from position 8 to position 12 and finally advances on to initial position 0 or 16 from position 12 as the read-out number 13 is decoded to operate solenoid S_{41}.

If the strip has been started through the reader in the wrong direction, the read-out number 13 is read in reverse which will be decoded by the circuitry of Fig. 4 as binary number "11" whereupon relay S_{40} is energized to operate an alarm and/or stop the conveyor drive motor.

In case the tape has been partially removed so that there are less than 16 pulse signals received from the tape, the wiper W_3 will not have proceeded to its correct end position in the gap of the distributor ring and FR_2 will be energized by the leave-pulse derived from the photocell gate.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention.

What is claimed is:

1. In a system for reading coded information carried by an article on a conveyor, said information being in the form of a plurality of indicia having two different characteristics thereby constituting a binary number code, a decoding system comprising: first photosensitive means arranged to scan said indicia and to provide first signal pulses in response to each indicia; second photosensitive means arranged to scan said indicia and to provide second signal pulses in response to indicia of only one characteristic; and binary-to-decimal converting means connected to said first and second photosensitive means and operable thereby to convert said first and second signal pulses to decimal information.

2. In a system for reading coded information carried by an article on a conveyor, said information being in the form of a plurality of indicia having two different

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characteristics thereby constituting a binary number code, a decoding system comprising: first photosensitive means arranged to scan said indicia and to provide first signal pulses in response to each indicia; second photosensitive means arranged to scan said indicia and to provide second signal pulses in response to indicia of only one characteristic; binary-to-decimal converting means connected to said first and second photosensitive means and operable thereby to convert said first and second signal pulses to decimal information; and means for indicating the absence of indicia from the article.

3. In a system for reading coded information carried by an article on a conveyor, said information being in the form of a plurality of indicia having two different characteristics thereby constituting a binary number code, a decoding system comprising: first photosensitive means arranged to scan said indicia and to provide first signal pulses in response to each indicia; second photosensitive means arranged to scan said indicia and to provide second signal pulses in response to indicia of only one characteristic; binary-to-decimal converting means connected to said first and second photosensitive means and operable thereby to convert said first and second signal pulses to decimal information; third photosensitive means arranged to sense entrance and exit of the article from the area of scanning of said first and second photosensitive means; and means connected in circuit with said third photosensitive means and operable thereby for indicating absence of indicia from the article.

4. In a system for reading coded information carried by an article on a conveyor, said information being in the form of a first group of indicia having two different characteristics thereby constituting a binary number code and a second group of indicia also having two different characteristics for indicating the correct direction of reading the first group of indicia, a decoding system comprising: first photosensitive means arranged to scan said indicia and to provide first signal pulses in response to each indicia; second photosensitive means arranged to scan said indicia and to provide second signal pulses in response to indicia of only one characteristic; and binary-to-decimal converting means connected to said first and second photosensitive means and operable thereby to convert said first and second signal pulses to decimal information, said binary-to-decimal converting means including means operable in response to scanning by said first and second photosensitive means of one group of indicia ahead of the other group of indicia for indicating incorrect placing of the article on the conveyor.

5. In a system for reading coded information carried by an article on a conveyor, said information being in the form of a plurality of indicia having two different characteristics thereby constituting a binary number code, a decoding system comprising: first photosensitive means arranged to scan said indicia and to provide first signal pulses in response to each indicia; second photosensitive means arranged to scan said indicia and to provide second signal pulses in response to indicia of only one characteristic; binary-to-decimal converting means connected to said first and second photosensitive means and operable thereby to convert said first and second signal pulses to decimal information; and means connected to said binary-to-decimal converting means for registering said decimal information.

6. In a system for reading coded information carried by an article on a conveyor, said information being in the form of a first group of indicia having two different characteristics thereby constituting a binary number code and a second group of indicia also having two different characteristics for indicating the correct direction of reading the first group of indicia, a decoding system comprising: first photosensitive means arranged to scan said indicia and to provide first signal pulses in response to each indicia; second photosensitive means arranged to scan said indicia and to provide second signal pulses

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in response to indicia of only one characteristic; binary-to-decimal converting means connected to said first and second photosensitive means and operable thereby to convert said first and second signal pulses to decimal information, said binary-to-decimal converting means including means operable in response to scanning by said first and second photosensitive means of one group of indicia ahead of the other group of indicia for indicating incorrect placing of the article on the conveyor; means connected to said binary-to-decimal converting means for registering said decimal information; and means connected to said binary-to-decimal converting means and operable in response to scanning by said first and second photosensitive means of one group of indicia ahead of the other group of indicia for actuating said registering means when the article is correctly placed on the conveyor.

7. In a system for reading coded information carried by an article on a conveyor, said information being in the form of a first group of indicia having two different characteristics thereby constituting a binary number code and a second group of indicia also having two different characteristics for indicating the correct direction of reading the first group of indicia, a decoding system comprising: first photosensitive means arranged to scan said indicia and to provide first signal pulses in response to each indicia; second photosensitive means arranged to scan said indicia and to provide second signal pulses in response to indicia of only one characteristic; binary-to-decimal converting means connected to said first and second photosensitive means and operable thereby to convert said first and second signal pulses to decimal information, said binary-to-decimal converting means including means operable in response to scanning by said first and second photosensitive means of one group of indicia ahead of the other group of indicia for indicating incorrect placing of the article on the conveyor; means connected to said binary-to-decimal converting means for registering said decimal information; and means connected to said binary-to-decimal converting means and operable in response to scanning by said first and second photosensitive means of the groups of indicia in one order for indicating incorrect placing of the article on the conveyor and operable in response to scanning by said first and second photosensitive means of the groups of indicia in the other order for actuating said registering means when said article is correctly placed on the conveyor.

8. In a system for reading coded information carried by an article on a conveyor, said information being in the form of a predetermined number of indicia having two different characteristics thereby constituting a binary number code; a decoding system comprising: first photosensitive means arranged to scan said indicia and to provide first signal pulses in response to each indicia; second photosensitive means arranged to scan said indicia and to provide second signal pulses in response to indicia of only one characteristic; binary-to-decimal converting means connected to said first and second photosensitive means and operable thereby to convert said first and second signal pulses to decimal information; and means operable in response to scanning by said first and second photosensitive means of less than the predetermined number of indicia for indicating absence of the predetermined number of indicia from the article.

9. In a system for reading coded information carried by an article on a conveyor, said information being in the form of at least one group of a plurality of indicia having two different characteristics thereby constituting a binary number code, a decoding system comprising: a first photocell arranged to scan the indicia and to provide first signal pulses in response to each indicia; a second photocell arranged to scan the indicia and to provide second signal pulses in response to indicia of only one characteristic; and a binary-to-decimal con-

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verter for converting said first and second signal pulses to decimal information, said converter comprising stepping means connected to said first photocell and actuated thereby to advance one step in response to each said first signal pulse, switching means having a plurality of positions equal in number to the number of the indicia, said switching means being connected to said stepping means and operatively driven thereby so that said switching means advances to the next position responsive to each step of said stepping means, a plurality of groups of circuit establishing means equal in number to the number of indicia in each group of indicia, the first of said groups of circuit establishing means having only one circuit establishing means and each successive group of circuit establishing means having twice the number of circuit establishing means as the preceding group, each of said circuit establishing means having actuating means and deactuated and actuated positions, the actuating means of each of said groups of circuit establishing means being connected to a respective position of said switching means, each said circuit establishing means of each group being connected to one circuit establishing means of the next successive group in its deactivated position and to a different circuit establishing means of the next successive group in its actuated position, said second photocell being connected to said switching means so that a second signal pulse causes actuation of the circuit establishing means connected to the respective position of said switching means, and means connected to the deactuated and actuated positions respectively of the circuit establishing means of the last group of circuit establishing means for indicating the circuit established by said groups of circuit establishing means in response to said first and second signal pulses whereby said binary code is converted to decimal information.

10. In a system for reading coded information carried by an article on a conveyor, said information being in the form of a plurality of groups of indicia, said indicia having two different characteristics thereby constituting a binary number code, a decoding system comprising: a first photocell arranged to scan the indicia and to provide first signal pulses in response to each indicia; a second photocell arranged to scan the indicia and to provide second signal pulses in response to indicia of only one characteristic; and a binary-to-decimal converter for converting said first and second signal pulses to decimal information, said converter comprising stepping means connected to said first photocell and actuated thereby to advance one step in response to each said first signal pulse, switching means having a plurality of positions equal in number to the number of the indicia, the positions of said switching means forming groups corresponding to the groups of said indicia with respective positions of each group being connected together, said switching means being connected to said stepping means and operatively driven thereby so that said switching means advances to the next position responsive to each step of said stepping means, a plurality of groups of circuit establishing means equal in number to the number of indicia in each group of indicia, the first of said groups of circuit establishing means having only one circuit establishing means and each successive group of circuit establishing means having twice the number of circuit establishing means as the preceding group, each of said circuit establishing means having actuating means and deactuated and actuated positions, the actuating means of each of said groups of circuit establishing means being connected to respective positions of said switching means, each said circuit establishing means of each group being connected to one circuit establishing means of the next successive group in its deactivated position and to a different circuit establishing means of the next successive group in its actuated position, said second photocell being connected to said switching means so that a second signal pulse causes actuation of the circuit establishing means con-

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nected to the respective position of said switching means, each deactuated and actuated position of the circuit establishing means of the last group of circuit establishing means having a plurality of recorder actuating means connected thereto equal in number to the number of groups of the indicia, and other switching means having a number of positions equal in number to the number of groups of indicia, said positions of said other switching means being respectively connected to corresponding ones of said recorder actuating means, said other switching means being connected to said stepping means and operatively driven thereby so that said positions of said other switching means are respectively reached coincident with the last first signal pulse responsive to the last indicia of each group whereby said recorder actuating means indicate decimal information corresponding to the binary code.

11. In a system for reading coded information carried by an article on a conveyor, said information being in the form of at least one group of a plurality of indicia having two different characteristics thereby constituting a binary number code, a decoding system comprising: a first photocell arranged to scan the indicia and to provide first signal pulses in response to each indicia; a second photocell arranged to scan the indicia and to provide second signal pulses in response to indicia of only one characteristic; and a binary-to-decimal converter for converting said first and second signal pulses to decimal information, said converter comprising stepping means connected to said first photocell and actuated thereby to advance one step in response to each said first signal pulse, switching means having a plurality of positions equal in number to the number of the indicia, said switching means being connected to said stepping means and operatively driven thereby so that said switching means advances to the next position responsive to each step of said stepping means, a plurality of groups of circuit establishing means equal in number to the number of indicia in each group of indicia, the first of said groups of circuit establishing means having only one circuit establishing means and each successive group of circuit establishing means having twice the number of circuit establishing means as the preceding group, each of said circuit establishing means having actuating means and deactuated and actuated positions, the actuating means of each of said groups of circuit establishing means being connected to a respective position of said switching means, each said circuit establishing means of each group being connected to one circuit establishing means of the next successive group in its deactivated position and to a different circuit establishing means of the next successive group in its actuated position, said second photocell being connected to said switching means so that a second signal pulse causes actuation of the circuit establishing means connected to the responsive position of said switching means, means connected to the deactuated and actuated positions respectively of the circuit establishing means of the last group of circuit establishing means for indicating the circuit established by said groups of circuit establishing means in response to said first and second signal pulses whereby said binary code is converted to decimal information; a third photocell arranged to provide a signal responsive to passage of the article through the zone of scanning of said first and second photocells; means connected to said third photocell for providing a first pulse responsive to the article entering said zone and a second pulse responsive to the article leaving said zone; and circuit connections to said last-named means and arranged to provide an indication in response to both of said last-named pulses; said binary-to-decimal converter having means for disabling said last-named circuit connections in response to pulses from said first photocell whereby said last-named indication shows absence of indicia from said article.

12. In a system for reading coded information carried

by an article on a conveyor, said information being in the form of a plurality of groups of information-carrying indicia, said indicia having two different characteristics thereby constituting a binary number code, said article further having another group of indicia also having two different characteristics for indicating the correct direction of reading the information-carrying indicia, a decoding system comprising: a first photocell arranged to scan the indicia and to provide first signal pulses in response to each indicia; a second photocell arranged to scan the indicia and to provide second signal pulses in response to indicia of only one characteristic; and a binary-to-decimal converter for converting said first and second signal pulses to decimal information, said converter comprising stepping means connected to said first photocell and actuated thereby to advance one step in response to each said first signal pulse, switching means having a plurality of positions equal in number to the number of the indicia, the positions of said switching means forming groups corresponding to the groups of said indicia with respective positions of each group being connected together, said switching means being connected to said stepping means and operatively driven thereby so that said switching means advances to the next position responsive to each step of said stepping means, a plurality of groups of circuit establishing means equal in number to the number of indicia in each group of indicia, the first of said groups of circuit establishing means having only one circuit establishing means and each successive group of circuit establishing means having twice the number of circuit establishing means as the preceding group, each of said circuit establishing means having actuating means and deactuated and actuated positions, the actuating means of each of said groups of circuit establishing means being connected to respective positions of said switching means, each said circuit establishing means of each group being connected to one circuit establishing means of the next successive group in its deactivated position and to a different circuit establishing means of the next successive group in its actuated position, said second photocell being connected to said switching means so that a second signal pulse causes actuation of the circuit establishing means connected to the respective position of said switching means, each deactuated and actuated position of the circuit establishing means of the last group of circuit establishing means having a plurality of recorder actuating means connected thereto equal in number to the number of groups of the indicia, other switching means having a number of positions equal in number to the number of groups of indicia, said positions of said other switching means being respectively connected to corresponding ones of said recorder actuating means, said other switching means being connected to said stepping means and operatively driven thereby so that said positions of said other switching means are respectively reached coincident with the last first signal pulse responsive to the last indicia of each group whereby said recorder actuating means indicate decimal information corresponding to the binary code; reverse insertion indicating means connected between the actuated position of one of the circuit establishing means of said last group of circuit establishing means and the first position of said other switching means for providing indication of incorrect placing of the article on the conveyor in response to scanning by said first and second photocells of the other group of indicia ahead of the information-carrying groups; and read-out means connected between the actuated position of another circuit establishing means of said last group of circuit establishing means and the last position of said other switching means for providing an indication of correct placing of the article on the conveyor in response to scanning by said first and second photocells of the other groups of indicia after the information-carrying groups.

13. In a system for reading coded information carried by an article on a conveyor, said information being in the form of at least one group of a predetermined number of indicia having two different characteristics thereby constituting a binary number code; a decoding system comprising: a first photocell arranged to scan the indicia and to provide first signal pulses in response to each indicia; a second photocell arranged to scan the indicia and to provide second signal pulses in response to indicia of only one characteristic; and a binary-to-decimal converter for converting said first and second signal pulses to decimal information, said converter comprising stepping means connected to said first photocell and actuated thereby to advance one step in response to each said first signal pulse, switching means having a plurality of positions equal in number to the number of the indicia, said switching means being connected to said stepping means and operatively driven thereby so that said switching means advances to the next position responsive to each step of said stepping means, a plurality of groups of circuit establishing means equal in number to the number of indicia in each group of indicia, the first of said groups of circuit establishing means having only one circuit establishing means and each successive group of circuit establishing means having twice the number of circuit establishing means as the preceding group, each of said circuit establishing means having actuating means and deactuated and actuated positions, the actuating means of each of said groups of circuit establishing means being connected to a respective position of said switching means, each said circuit establishing meaans of each group being connected to one circuit establishing means of the next successive group in its deactivated position and to a different circuit establishing means of the next successive group in its actuated position, said second photocell being connected to said switching means so that a second signal pulse causes actuation of the circuit establishing means connected to the respective position of said switching means, means connected to the deactuated and actuated positions respectively of the circuit establishing means of the last group of circuit establishing means for indicating the circuit established by said groups of circuit establishing means in response to said first and second signal pulses whereby said binary code is converted to decimal information; another switching means connected to said stepping means and operatively driven thereby, said other switching means being arranged to complete a circuit in every position of said stepping means except the last; a third photocell arranged to provide a pulse responsive to exit of the article from the zone of scanning of said first and second photocells; and means connected in circuit with said third photocell and said other switching means for providing an indication of scanning by said first and second photocells of less than the predetermined number of indicia.

14. In combination an article having a group of marks, each mark having either one of two distinct colors, a first photocell and optical system being responsive only to either of said two colors, a second photocell and optical system responsive to one only of said colors, means to scan said marks with said photocells, a stepping magnet and ratchet wheel coupled electrically to said first photocell, a commutator with a wiper and segments corresponding in number to the number of said marks, a binary-to-decimal converter connected to said segments, means for driving said wiper by said ratchet wheel, means for connecting said wiper to one of said photocells, and means for connecting said stepping magnet to the other of said photocells.

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RAILWAY CAR IDENTIFICATION SYSTEM

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Fig. 1.

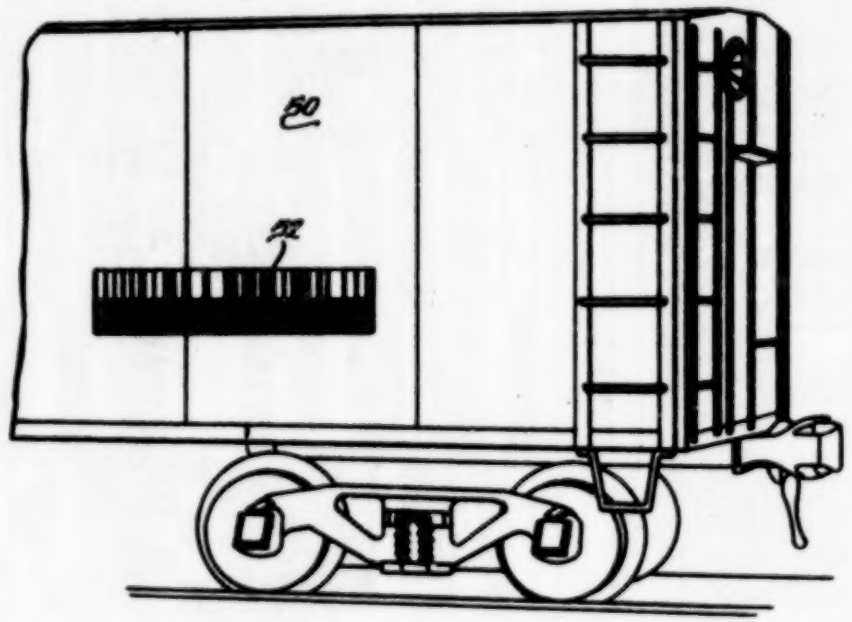
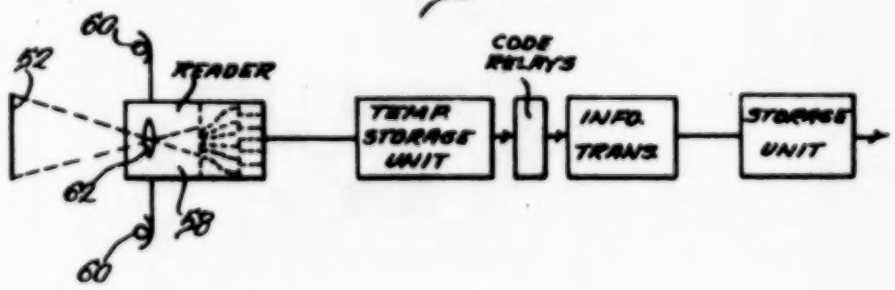


Fig. 2.



INVENTORS.
Stanley C. Kolanowski
Maryan W. Flaga
Edward W. Ernst
By: Wyman, Bradford & Hoe
Attys.

Oct. 8, 1963 S. C. KOLANOWSKI ETAL 3,106,706

RAILWAY CAR IDENTIFICATION SYSTEM

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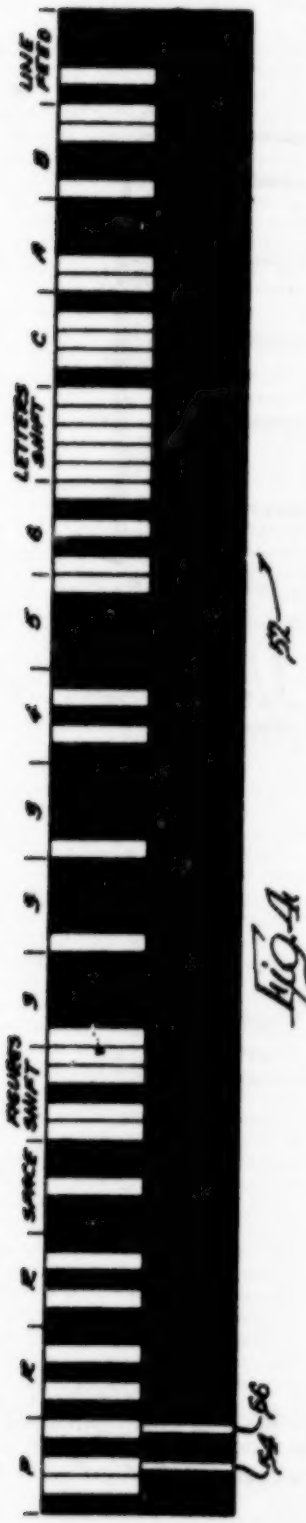

Fig. 4

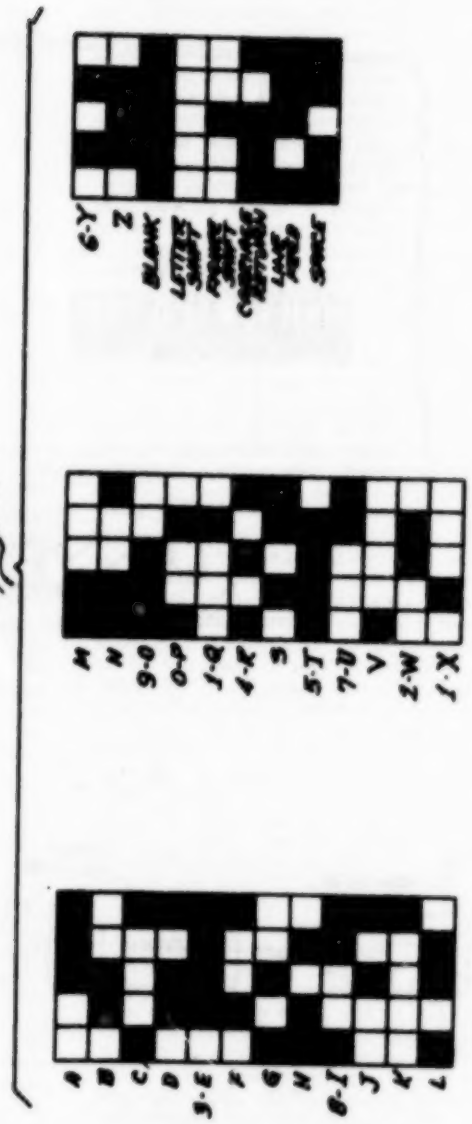

Fig. 3

INVENTORS.
Stanley C. Kolanowski
Maryan W. Plaga
Edward W. Ernst
By: Hyman, Sandfort & Love

Oct. 8, 1963 S. C. KOLANOWSKI ETAL 3,106,706

RAILWAY CAR IDENTIFICATION SYSTEM

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Fig. 5.

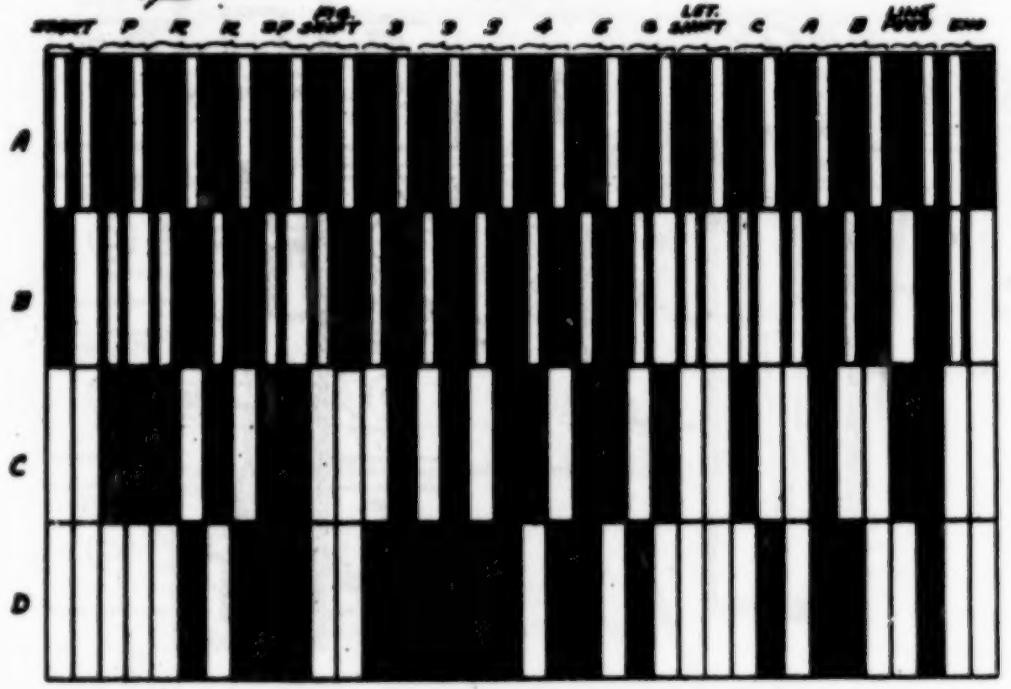
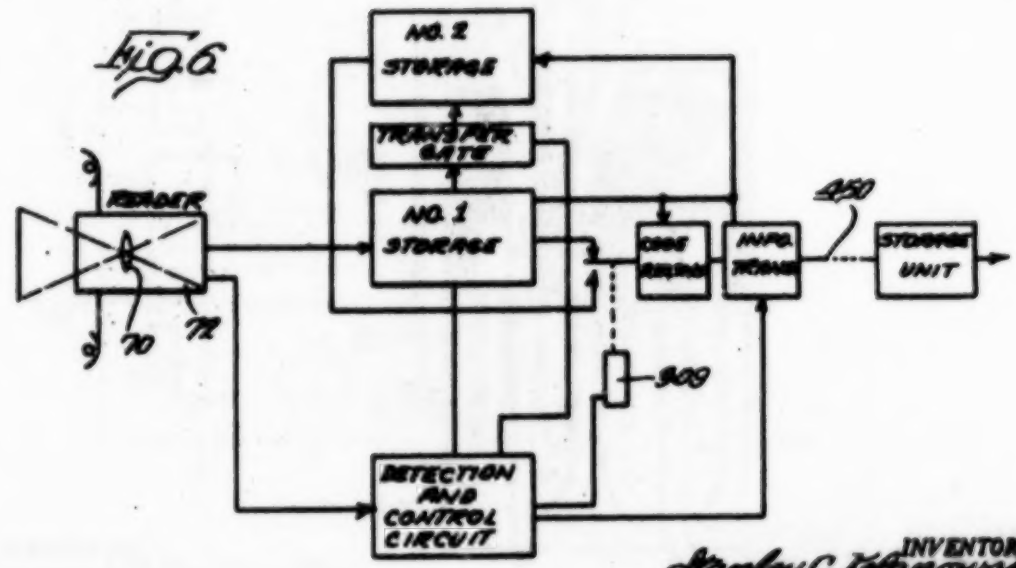


Fig. 6



INVENTORS.
Stanley C. Kolanowski
Maryan W. Plaga
Edward W. Ernst
By: Hyman, Sandfort & Love

Oct. 8, 1963 S. C. KOLANOWSKI ET AL 3,106,706

RAILWAY CAR IDENTIFICATION SYSTEM

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Fig. 7.

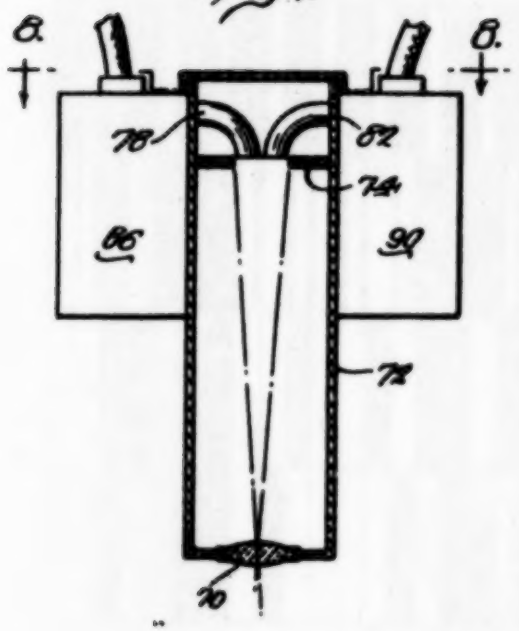
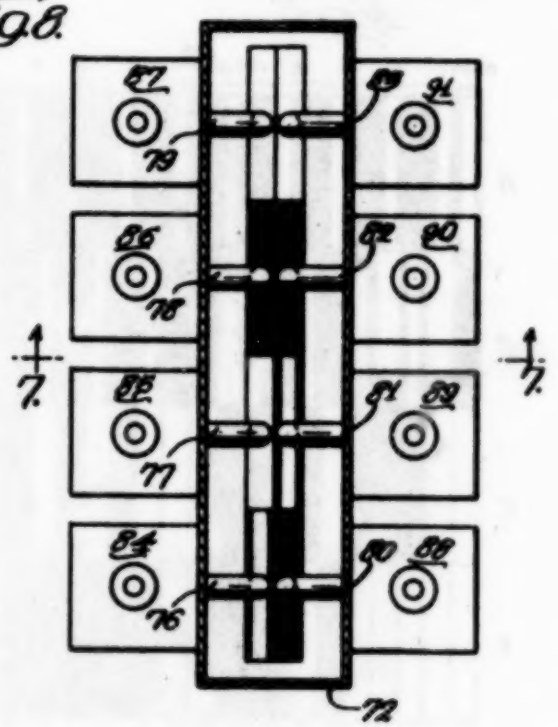


Fig. 8.



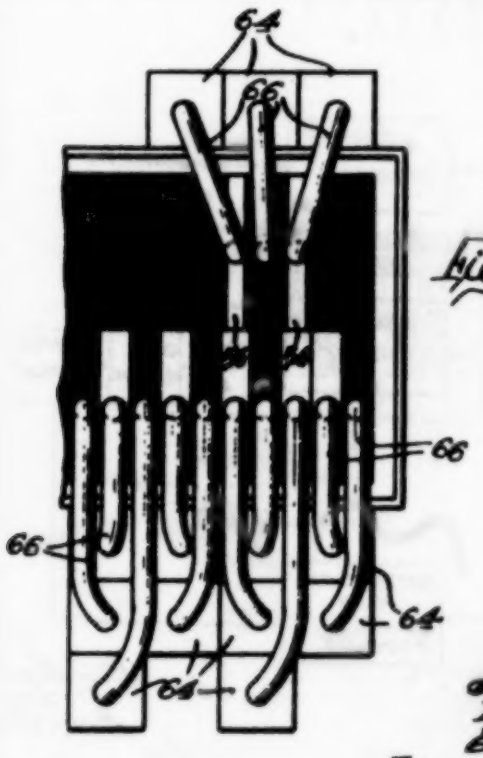


Fig. 9.

INVENTORS
Stanley C. Kolanowski
Maryan W. Plaga
Edward W. Ehrlich
By: Wyman, Seabold & Love
Attys.

Oct. 8, 1963 S. C. KOLANOWSKI ET AL 3,106,706

RAILWAY CAR IDENTIFICATION SYSTEM

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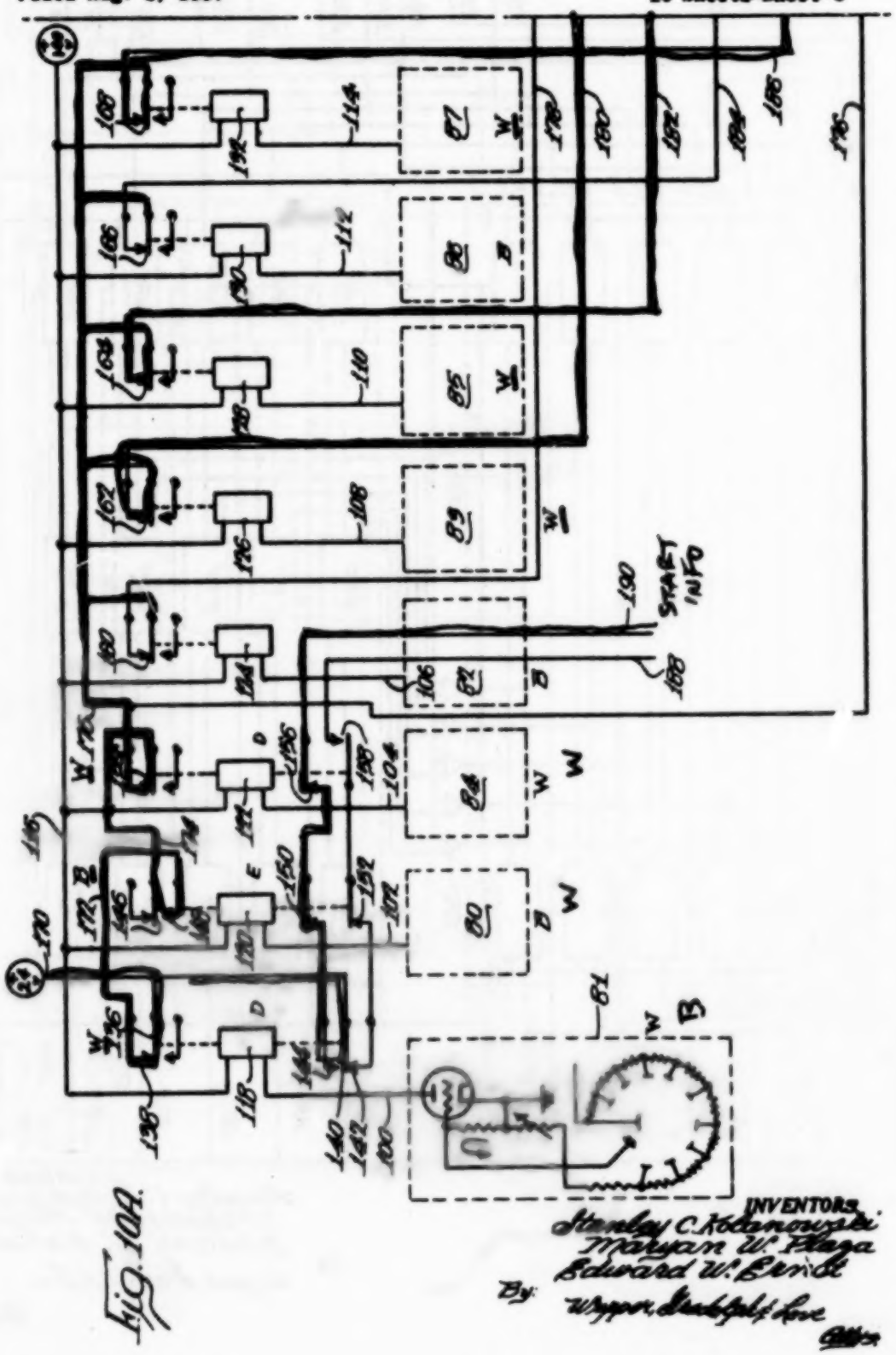

Fig. 10.

INVENTORS
Stanley C. Kolanowski
Maryan W. Plaga
Edward W. Ehrlich
By: Wyman, Seabold & Love
Attys.

Oct. 8, 1963 S. C. KOLANOWSKI ETAL 3,106,706

RAILWAY CAR IDENTIFICATION SYSTEM

Filed Aug. 8, 1957 10 Sheets-Sheet 6

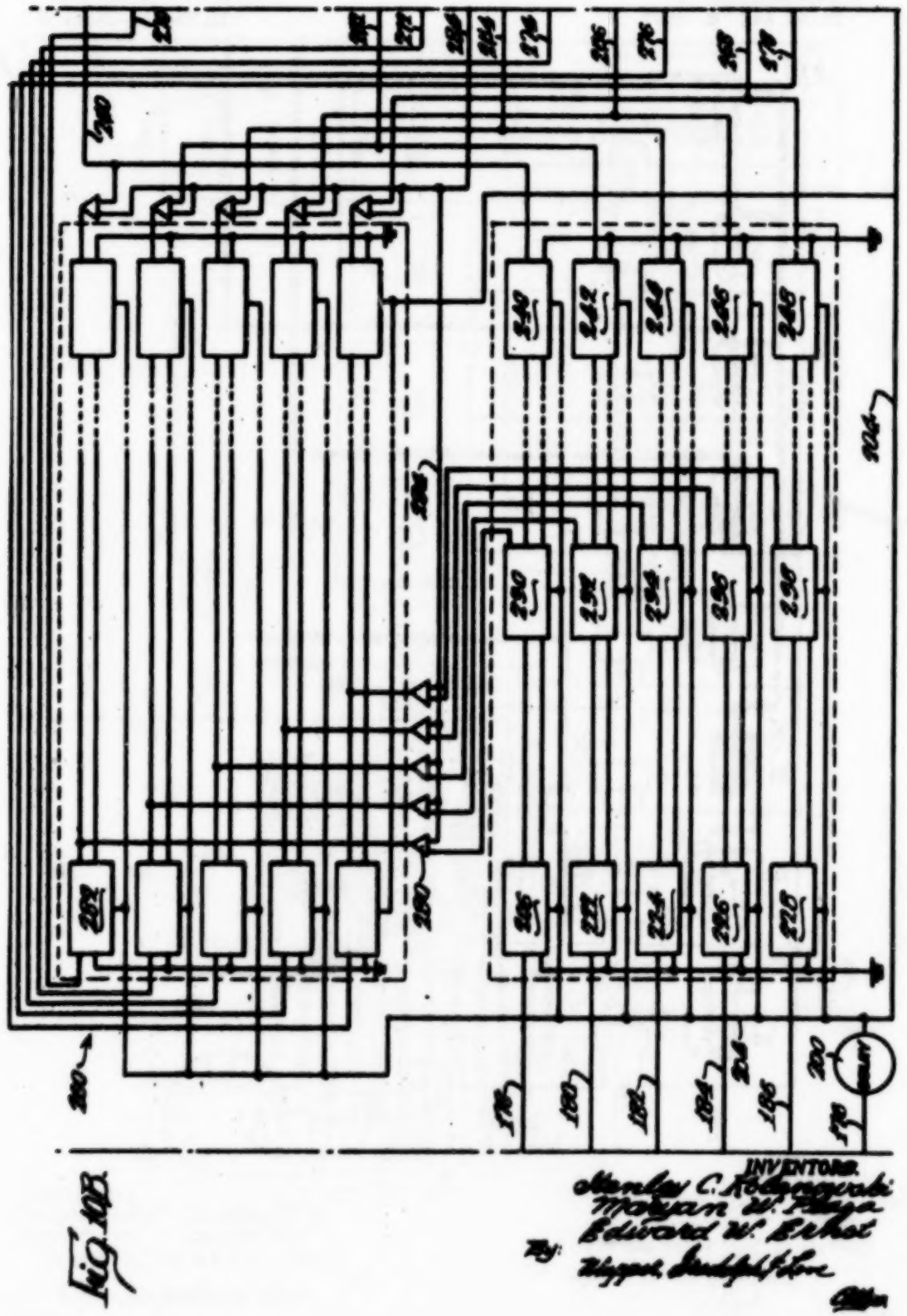

Fig. 10B

INVENTORS.
Stanley C. Kolanowski
Mahjan W. Pitaga
Edward W. Bihot
By: Wyper, Kirkpatrick & Hone
Attys.

Oct. 8, 1963 S. C. KOLANOWSKI ETAL 3,106,706

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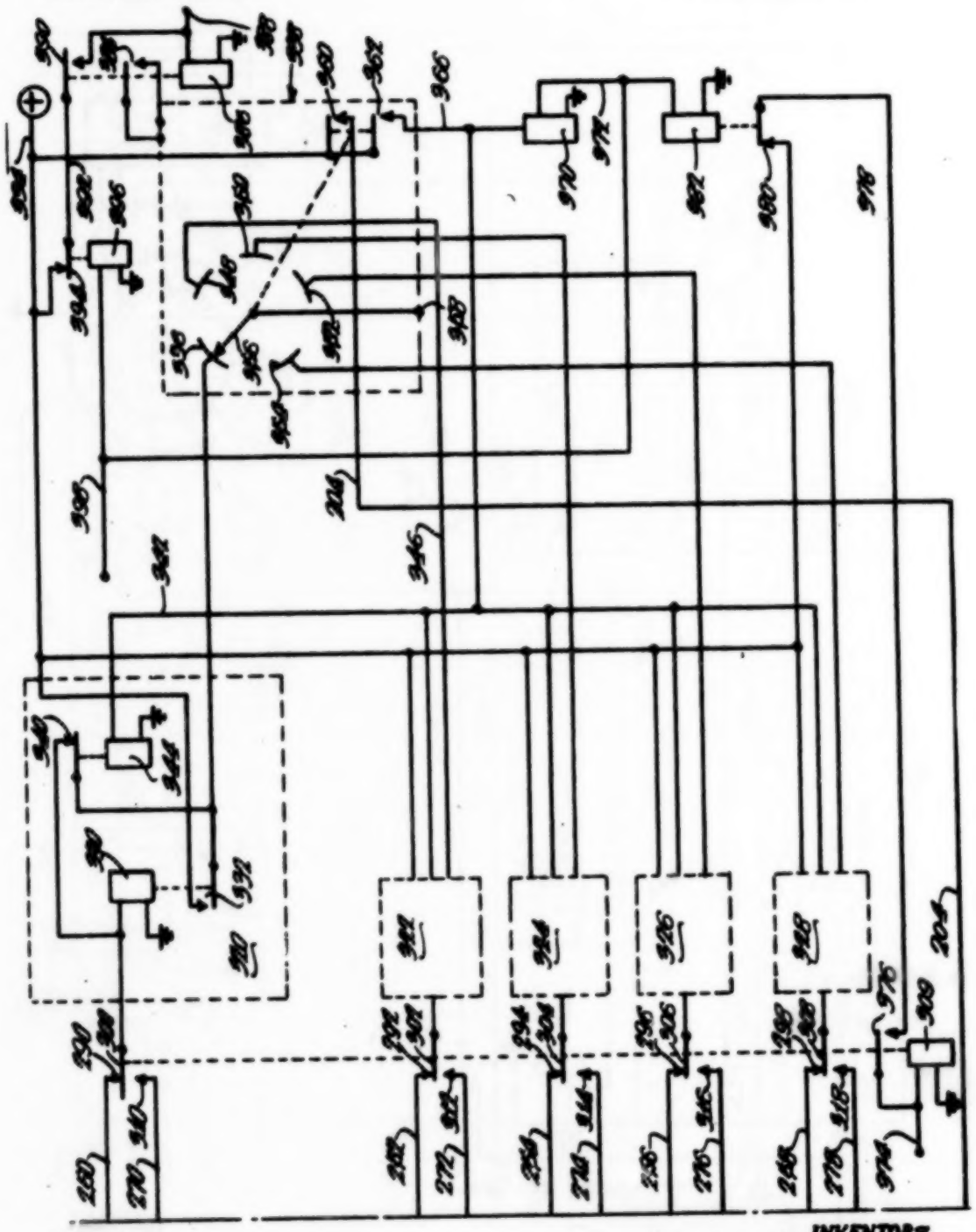

Fig. 10C.

INVENTORS.
Stanley C. Kolanowski
Mahjan W. Pitaga
Edward W. Bihot
By: Wyper, Kirkpatrick & Hone
Attys.

Oct. 8, 1963 S. C. KOLANOWSKI ETAL 3,106,706

RAILWAY CAR IDENTIFICATION SYSTEM

Filed Aug. 8, 1957 10 Sheets-Sheet 8

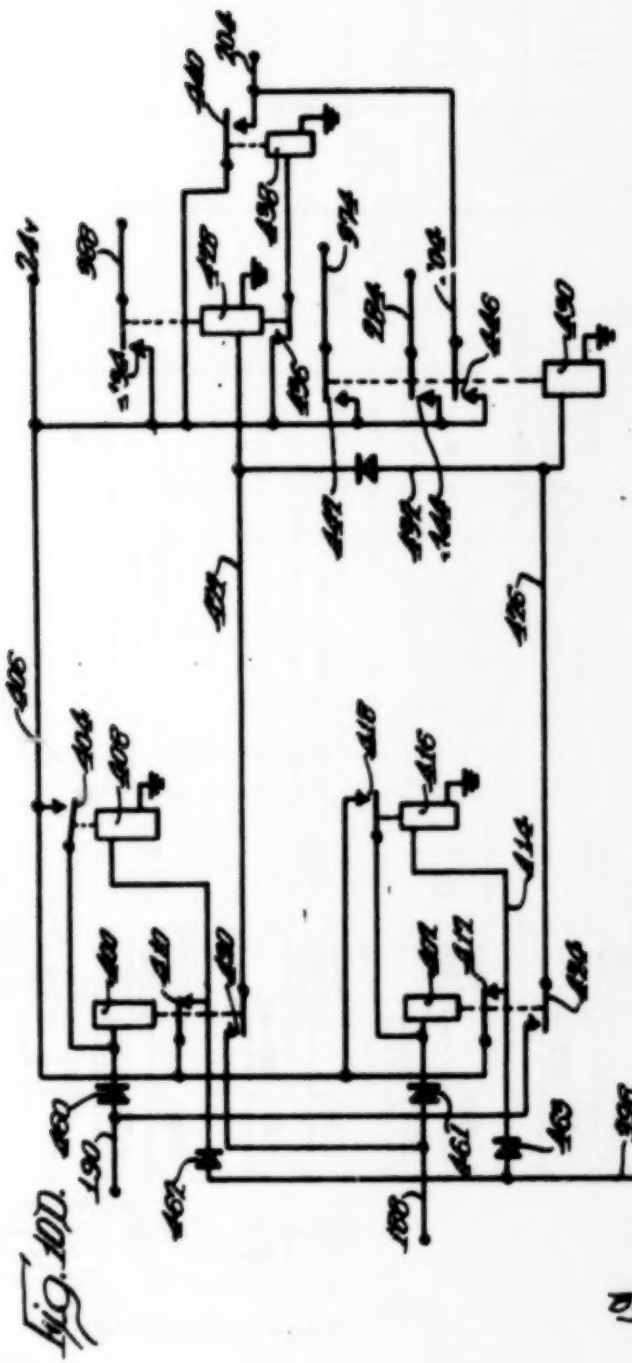

Fig. 10A.

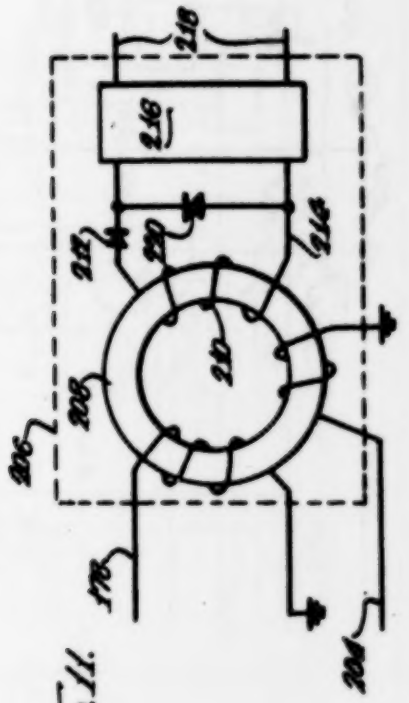

Fig. 11.

INVENTORS
Stanley C. Kolanowski
Maryan W. Plaga
Edward W. Ernst
By Hyman Sudolsky & Lee
Attys.

Oct. 8, 1963 S. C. KOLANOWSKI ETAL 3,106,706

RAILWAY CAR IDENTIFICATION SYSTEM

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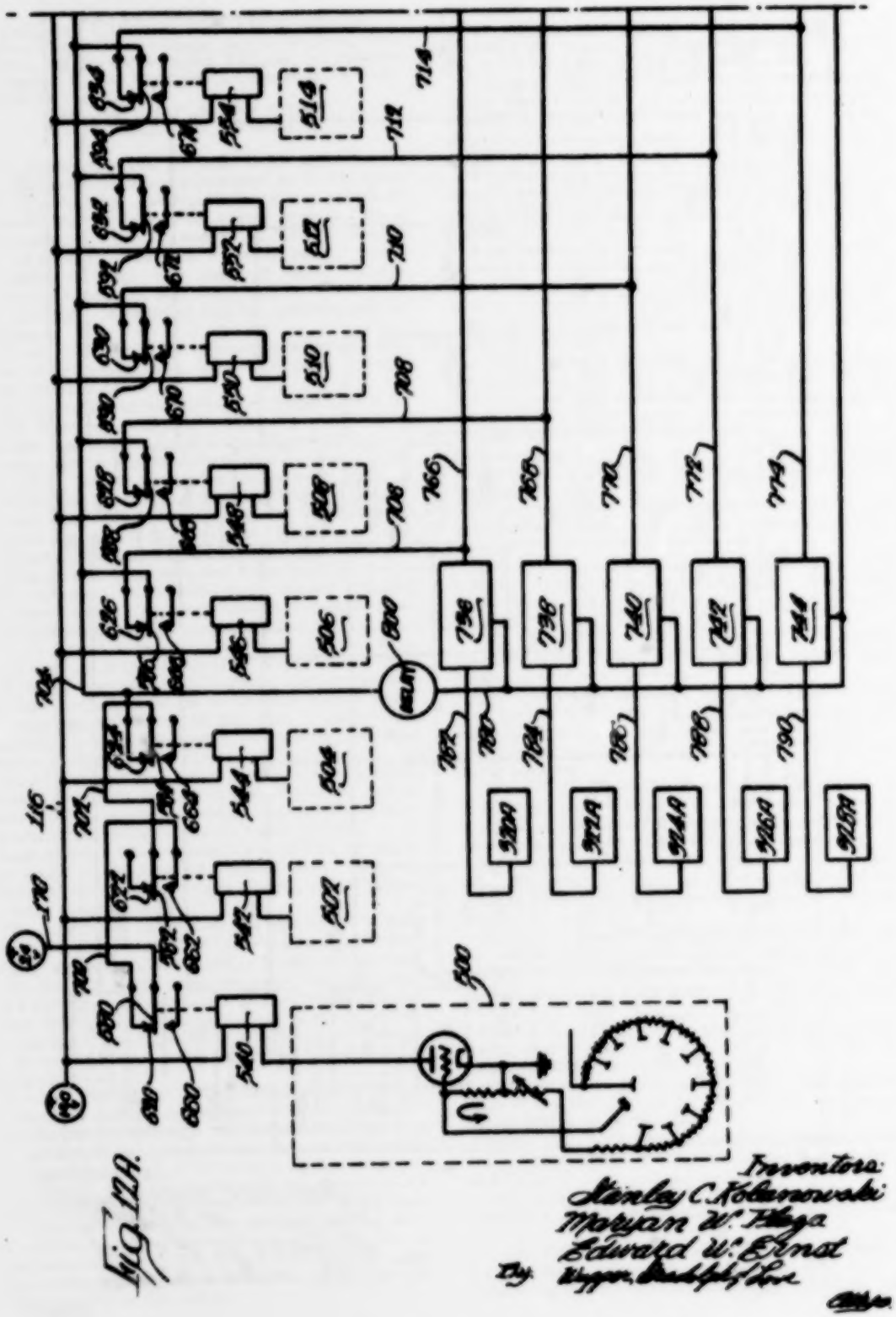

Fig. 10B.

Inventors
Stanley C. Kolanowski
Maryan W. Plaga
Edward W. Ernst
By Hyman Sudolsky & Lee
Attys.

Oct. 8, 1963 S. C. KOLANOWSKI ET AL 3,106,706

RAILWAY CAR IDENTIFICATION SYSTEM

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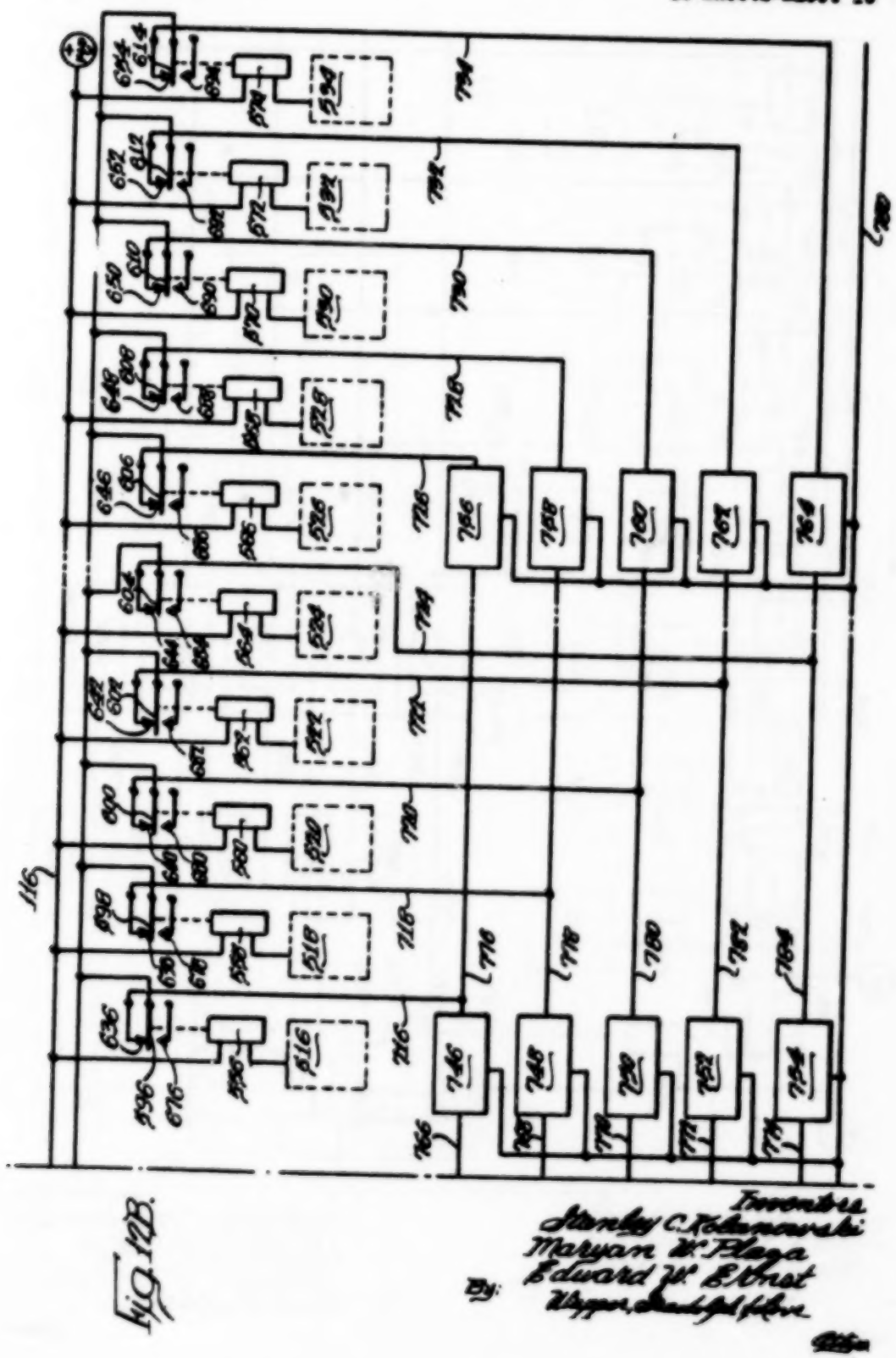

Fig. 12B

Inventors
Stanley C. Kolanowski
Maryan W. Plaga
Edward W. Ernst
By: Wegner, Stenfield & Stone
Attys.

United States Patent Office

3,106,706
Patented Oct. 8, 1963

3,106,706
RAILWAY CAR IDENTIFICATION SYSTEM
Stanley C. Kolanowski, Chicago, Maryan W. Plaga, River Grove, and Edward W. Ernst, Elmhurst, Ill., assignors to Stewart-Warner Corporation, Chicago, Ill., a corporation of Virginia
Filed Aug. 8, 1957, Ser. No. 677,869
19 Claims. (Cl. 340—345)

Our invention relates generally to an apparatus for recording and translating information as to the movement of freight and passenger railroad cars, which information may be utilized for improvement in railroad traffic control, for interline accounting, for increasing the speed of assembly of cars into trains, for making records of weights of freight cars and their loads, recording analyses of samples of bulk loads, and in various other ways facilitating economical railroad operation and accounting.

The invention may be best understood following a brief review of the present methods of operation of railroads in the United States.

The two million or so railway cars in operation in the United States are owned individually by a number of railroads, but are routed over many different lines. The company owning a particular car receives from the line upon which the car is traveling, or upon the tracks of which it is standing, a per diem rental fee. Thus it is apparent that highly complex accounting procedures are necessary for allotting to each railroad for the many cars which may be owned by it, the per diem total owed to it by other railway companies, and those which it owes to other railroads. Additionally, each railroad company must have records upon which demurrage must be computed and billed to the shipper or to the consignee.

In practice, it is customary to record the date upon which each car is transferred from one line to another. Such records are generally individually made by the several lines over which the car is traveling or upon which it is standing, with the result that there is considerable duplication in accounting effort, because as each train leaves a marshaling yard, the "consist" of the train, the railroad name, and the number of cars must be manully recorded so that the location of each of the cars may be determined continuously to enable a computation of interline credits and debits for the car rental per diem.

Such records of the "consist" of each train of cars is also useful in checking the waybills from which the division of the tariffs, or freight charges, among several railroads is determined.

The information relative to the "consist" of a train usually is sent by telegraph or Teletype from one checking point to another, and this involves further clerical work in the course of wh ch errors may occur, with the consequent necessity for rechecking. In fact, because of such errors freight cars frequently become "lost," with consequent loss of revenue to the owner thereof and increase in the cost of freight service due to the lack of full use of the equipment.

It is thus an object of the present invention to provide an improved method and means for rapidly and automatically identifying freight cars as to ownership, number, and type, as the trains move out of or into marshaling yard and past other check locations, to obviate the necessity of a clerk for manually checking and recording such identification data, and to provide a record in the form of a punched tabulating card or other information storing medium, usually providing a printed record, and in some instances providing means for automatically or semi-automatically transmitting such information by Teletype, or the like to a remote station.

A further object is to provide indicia upon a railroad car adapted to be read by a stationary photoelectric means, and in which the indicia includes markings for triggering the reading of the remaining indicia on the car, as the car is moving past the reading means.

A further object is to provide a method of reading indicia from a railroad car while it is in motion, temporarily storing the indicia which has been read, reading out the indicia temporarily stored, and recording the read out indicia.

A further object is to provide means and a method for attaining the above objectives, while a train of railroad cars is moving at high speed relative to the means for reading the indicia on the cars.

A further object is to provide a method and apparatus whereby the indicia on the railroad car can be in a standard quasibinary code, such as the Teletype or bident code for instance, so that commercially available equipment can be used for information transmission and for computing operations.

A further object is to provide means for accomplishing the methods set forth in the foregoing objects, in a simple and economical manner, utilizing quite largely components which are well known and available commercially.

Other objects and advantages will become apparent from the following description of a preferred embodiment of our invention which is illustrated in the accompanying drawings.

In the drawings in which similar characters of reference refer to similar elements throughout the several views:

FIG. 1 is a diagrammatic representation of one end of a railway freight car, shown with a typical information panel thereon, the panel being coded according to teachings of the present invention;

FIG. 2 is a simplified block diagram showing one form the information reading and transmitting system may take;

FIG. 3 is a table showing a suitable five place binary code for use in carrying out the present invention, this particular code being well known and comprising the standard Teletype or bident code as adapted for the particular purpose;

FIG. 4 is an illustration of a coded panel similar to that in FIG. 1, for instance, which has been arranged to convey typical information of the type contemplated by the present invention by application of the code of FIG. 3;

FIG. 5 is an illustration of a different form of coded panel, this panel conveying the same information as the panel of FIG. 4 and being also based upon the code of FIG. 3;

FIG. 6 is a block diagram showing another form the information reading and transmitting system may take;

FIG. 7 is a diagrammatic horizontal sectional view through the reading instrument shown toward the left in FIG. 6;

FIG. 8 is a diagrammatic view of the back of the reader, shown with the cover removed as indicated by the arrows along the line 8—8 of FIG. 7;

FIG. 9 is a view similar to FIG. 8, but illustrating the back of a reader adapted for operation in the type of system illustrated in FIG. 2;

FIGS. 10A, B, C, and D is a circuit diagram of the major portion of the equipment illustrated in block form in FIG. 6;

FIG. 11 is a circuit detail in diagrammatic form which amplifies a portion of the block diagram of FIG. 10B; and

FIGS. 12A and B is a circuit diagram of a portion of the equipment illustrated in block form in FIG. 2.

Referring to FIG. 1 of the drawings, a freight car has

been illustrated at 50 and needs no special description. An information panel 52 is shown as being attached to the side thereof in a relatively low position. This panel may be located in any desired position upon the car, but the position must be standardized from car to car so as to enable the reader, to be described presently, to find the panel and translate information therefrom without error. Physically the panel may most simply comprise a board painted, as indicated in greater detail in FIGS. 4 and 5, with black and white or other contrasting stripes according to the information to be coded thereon. The information panel as thus prepared is then attached to the car in any suitable fashion.

Panels generally similar to those shown in FIGS. 4 and 5 may be used with either of the alternative systems to be described. However, for purposes of this application, the panels of FIGS. 4 and 5 have been especially adapted for the systems of FIGS. 6 and 2 respectively.

As shown in detail in FIG. 4, which illustrates a panel coded to contain typical information of the type contemplated, the upper row of stripes above the center line is arranged in groups of five according to the code of FIG. 3.

In FIG. 4 the first group of five stripes is in the order of black-white-white-black-white. From FIG. 3 it will be noted that this is the code representation for the letter P. The next group of five stripes is in the order black-white-black-white-black, which is the code for the letter R. The next group of five is a duplicate of the last and therefore also indicates the letter R. The letters P R R are followed by five stripes in the order black-black-white-black-black, which is the code symbol for a space or unused portion of the code. Thus the first four groups of letters identify the particular car as belonging to the Pennsylvania Railroad. Although only three spaces are needed to identify the Pennsylvania Railroad, four identifying spaces are provided on the panel because some railroads will need four code letters for their identification if all of the railroads in operation in the United States, Canada and Mexico are to be individually identified.

The fourth space in the code is followed by five stripes or bars in the order white-white-black-white-white, which is the symbol for figure shift. This is the arrangement used in the standard Teletype code system for indicating to a translator that the following group of symbols represents numbers rather than letters.

The figure shift symbol is followed by a five-bar design in the order white-black-black-black-black, which indicates the number 3. It will be noted that the panel provides space for six numbers which, as shown, are coded to represent in order the numbers three-three-three-four-five-six.

This provision for a six digit number is more than adequate to individually serial number all of the freight car and passenger cars owned or likely to be owned by any of the railroads.

The last of the numbers on the panel is followed by a five-bar design with the stripes in the order white-white-white-white-white. This is the Teletype code symbol for letter shift and informs the translating apparatus that the code symbols to follow are for letters rather than numbers. The next three five-stripe sections of the panel provide space for identifying the type of railway car. In the present instance the letters *c*, *a*, *b* are represented and identify the car as a caboose. Three letters are sufficient to identify all of the types of cars in railway use. The last portion of the panel, consisting of the five-bar design black-white-black-black-black, is the code symbol for line feed which informs the translator that the information about the particular car has been concluded and that the translator should shift or reset and prepare to record the information from the next following car.

Below the center line, the panel of FIG. 4 is all black excepting for two-spaced white stripes with a black stripe therebetween. This design of white-black-white is used for alignment purposes and tells the reading apparatus when the panel has arrived at such a position that it is to be read. In order to insure that alignment is precise, the white stripes 54 and 56 are only half as wide as the stripes in the upper portion of the design, and thus when these half width stripes are properly aligned for reading it is certain that those above in the coded portion of the panel are in precisely the correct position. The panel 52 may be of any convenient size but should be standardized. Conveniently, the panel can be twelve inches high so that each of the code stripes is six inches long and of a length such that each stripe is one inch wide. The reader is arranged to be sensitive to a small area, and is adjusted to read at a height occupied by approximately the central portion of the striped area. Thus, changes in loading of the car or sway as it passes the reader will not introduce errors, since the panel 52 may move upwardly or downwardly considerably with respect to the position of the reader, without changing the design as observed by the reader.

In FIG. 2, the panel 52 is shown before a reader at 58. Essentially this device consists of a source of illumination as at 60, and an arrangement for forming an image of the panel 52 on the sensitive elements of a group of photoelectric cells. It consists of a lens 62 which may be the equivalent of a camera lens, although its quality of correction need not be as good as that found in most photographic cameras. This lens forms an image of the panel at its focal plane, and at the focal plane is a group of light-sensitive elements arranged in a pattern so as to coincide with the pattern of the panel image. As shown in FIG. 9, this can consist of a bank of photoelectric cells 64 conveniently positioned with bent rods 66 of methylmethacrylate arranged to conduct light from the focal plane image positions to the individual photocells. The panel arrangement of FIG. 4 as shown requires eighty photocells and light conducting rods to receive and translate the information from the coded top portion of the panel of FIG. 4 plus three more to receive the alignment information from the white stripes 54 and 56 and the intervening black stripe.

In FIG. 9 a portion of the information panel of FIG. 4 is shown as it would appear in the reader at the moment of reading. Because of the intervening lens 62, the image is inverted and reversed. It will be noted that the white stripes 54 and 56 and the intervening black stripe are in alignment with the light conducting rods 66 leading to the appropriate photocells. The three photocells at the upper portion of diagram 9, therefore, read white-black-white, which signals that the image of the coded panel is in position to be read. As will be explained presently, this triggers the apparatus to read the instantaneous light condition at each of the eighty photocells shown in the lower portion of the diagram. Reading from the right, therefore, to the place where the diagram is broken away in the interest of saving space, the group of photocells see in order, black-white-white-black-white-black-white-black-white-black, which is the first portion of the panel of FIG. 4 and includes the code information for the letters P and R.

The simultaneous type of reader described above, therefore, takes all information from the panel of FIG. 4 instantaneously. This requires a considerable duplication of equipment, but has the advantage that it is insensitive to the direction of movement of the car. Once the panel has been brought into alignment with the reader and is ready to be read, it makes no difference to the reader in which direction it is moving. The reader of FIGS. 7 and 8 which uses the information panel of FIG. 5, is simpler in that it requires only eight photocells for its operation rather than eighty-three. This is accomplished by reading the information from the panel character by character and accumulating the information until it has

all been stored. Some complexity, however, is introduced by the fact that the information may be accumulated in either direction, depending upon the direction of movement of the car. It is necessary, therefore, to reorient the information before it is further processed.

The coded panel of FIG. 5 has four sets of stripes, labeled for convenience, from top to bottom, as A, B, C and D. Each of the stripe positions in the present example is six inches high and one inch wide, as in the panel of FIG. 4. Each character represented is two stripe spaces wide. With this presentation, each character which is four stripes high and two stripes wide is read simultaneously; and these two inch bands are read in succession from either end as the car moves past the reader. Although many types of coding may be used, that shown is as follows: Ignoring for the moment the first band at the left, labeled "Start" and taking the next band of two stripes labeled "P," this is so arranged that the first stripe in row B is white and of half width. The one directly thereabove in row A is black. The other stripe in row A is white and of half width. These three stripes correspond to the white-black-white stripes 54–56 of FIG. 4; that is, they are there to inform the reader when a character frame two stripes wide is in position to be read. The first stripe in row C is the first stripe of the five place code; and, since the letter P is represented, it is black, as is the first stripe to the left in FIG. 4. The one directly therebeneath in row D is the second place in the code and is white as is the second stripe of FIG. 4. The second stripe in row B represents the third place in the code and is white, as is the third stripe of FIG. 4. The one directly therebeneath—that is, the second stripe in row C—represents the fourth place in the code; and the one beneath this—that is, the second stripe in row D—is the last place in the code.

It will be noted that each two-stripe frame repeats the white-black-white design with half width white stripes, for the purpose of informing the reader that the particular frame is in position to be read, and that the remaining five stripes in the order given above are used as the code symbol. Comparison will indicate that the panel of FIG. 5, therefore, gives precisely the same information as the panel of FIG. 4. For convenience, the information given is indicated across the top of the panel.

At the left hand edge of FIG. 5, the first two-stripe design labeled "start" at the top has stripes in the order of black-white-white, where normally this position is occupied by the frame centering white-black-white design. The black-white-white arrangement, as will be explained in greater detail presently, informs the reader that the coded panel is being read at the left hand edge. At the right hand end of the panel, the last character position is occupied by stripes in the order of white-white-black. This informs the reader that it is scanning the right hand end of the card. Thus if the left hand or "start" signal is received before the right hand or "end" signal, the car is moving from right to left and the information is taken in the proper order; whereas, if the "end" signal is received first, the car is moving from left to right and the information will be reversed.

The reader for the panel of FIG. 5 is illustrated in FIGS. 7 and 8 and is simpler than that of FIG. 9, since it requires only eight photocells, which may be arranged as shown. Here a lens 70, in a light-tight housing 72, brings the image of the panel into focus at a focal plane 74. Appropriately bent rods formed of methylmethacrylate have their ends properly positioned at the focal plane. These rods are indicated in FIG. 8 by the numerals 76 to 83 inclusive. At their opposite ends these rods lead into photocell housings indicated, respectively, at 84 to 91. By comparing FIG. 5 with the inverted and reversed image shown in FIG. 8, it will be seen that at the instant shown, the reader is scanning the symbol for the letter P as follows: Photocells 84, 88, and 89, are observing the white-black-white design which indicates that a frame is in position to be read. Cells 90, 91, 85, 86 and 87 observe, respectively, black-white-white-black-white or the symbol for letter P.

In both the readers of FIGS. 7 and 8 and FIG. 9, it is possible to arrange the individual photocells directly at the focal plane and dispense with the light conducting rods if desired. With this arrangement we prefer to use photosensitive junction transistors such as the Clarex type CL2 solid state photocell for instance. The use of junction transistors ordinarily is to be preferred since the mechanism is simpler and less costly than the arrangement shown. The system illustrated using photo-multiplier tubes of the 931A type, may have an advantage in some instances, however, where a very high order of sensitivity is desired.

Referring now to FIG. 10A of the drawings, the photo multiplier tube is shown at 81 and may be considered as of type 931A for instance. It is connected through a conventional triode D.C. amplifier to an output lead 100. The triode normally conducts. However, when a white stripe is detected, the multiplier tube 81 conducts to negatively bias the triode below cutoff; and the triode ceases to conduct.

The other identical phototube and amplifier circuits are shown in boxes labeled 80, 84, 82, 83, 85, 86 and 87 having output leads indicated, respectively, at 102, 104, 106, 108, 110, 112 and 114. Each of these leads is connected to a B-plus power line 116 through its own relay coil, these coils being indicated from the left by the numerals 118, 120, 122, 124, 126, 128, 130, and 132. Each of these coils operates one or more sets of contacts, and for convenience all of the contacts are shown in the positions they assume when the photocells are illuminated and hence the relay coils are deenergized.

Specifically, relay coil 18 operates a movable contact 136 which is associated with contact 138 when the coil 118 is deenergized. Energization of the coil 118 opens the circuit through contacts 136–138. This coil also operates a movable contact 140 which makes a circuit through contact 142 when the coil 118 is deenergized, and through a contact 144 when the relay is energized by sufficiently reducing the light falling upon the photocell at 81. Contacts associated with relay coil 120 are as follows: Energization of this coil makes a circuit between relay contacts 146 and 148, this circuit being opened upon deenergization of the coil 120. Two other sets of contacts at 150 and 152 are normally closed, circuits through these contacts being opened upon energization of the coil 120.

Normally closed relay contacts 154 are opened upon energization of relay coil 122 as are normally closed contacts 156. A set of normally open contacts at 158 close when relay coil 122 is energized. Relay coils 124, 126, 130 and 132 each operate, when energized in such fashion, to open, respectively, sets of normally closed contacts at 160, 162, 164, 166 and 168.

A relay operating voltage, +24 volts for instance, is connected to lead 170. This lead is connected in turn to the movable relay contacts 136 and 140. Relay contact 138 is connected by a lead 172 to contact 148. Contact 146 is connected to one of the contacts 154, the other being connected to a bus 176. This bus is also connected to one each of the contacts of sets 160, 162, 164, 166 and 168, the other contacts in the sets being connected, respectively, to leads 178, 180, 182, 184 and 186.

Contact 142 is connected to one of the contacts in the set 152, the other contact in this set being connected to one of the contacts in the set 158 and the other in this set being connected to a lead 188. Contact 144 is connected through contacts 140 and 156 in series, to a lead indicated at 190.

Analysis of the above circuit shows that when photocells in the circuits of 81, 80 and 84 are observing stripes which are white-black-white in that order, relay coil 118 will be deenergized, coil 120 will be energized, and coil 122 will be deenergized. Under these conditions relay

power lead 170 will be connected through contacts 136–138, contacts 148–146 and contacts 154 to line 176 thereby energizing this line and one of the contacts in each of the sets 160, 162, 164, 166, and 168 so that this voltage will appear in the output leads 178, 180, 182, 184 and 186 whenever the photocells 82, 83, 85, 86 and 87 are illuminated. Thus, the white-black-white pattern on the cells 81, 80 and 84 energizes the output leads 178 to 186 whenever the photocells operating these outputs is observing a white line, but in those instances where a particular photocell is observing a black line, its output lead will be deenergized.

Whenever the cells 81, 80 and 84 in that order observe a black-white-white pattern, the relay power lead 170 will be connected through contacts 140–144 and contacts 150 and 156 in series to the lead 190 which is therefore energized whenever the "start-of-information" frame at the left hand edge of FIG. 5 is in front of the reader. Similarly, when the cells 81, 80 and 84 in that order observe the pattern white-white-black, the relay voltage line 170 will be connected through contacts 140–142 and contacts 152 and 158 in series, to lead 188, thereby energizing this lead whenever the "end-of-information" frame at the right hand end of FIG. 5 is before the reader.

The storage circuit for the information is shown diagrammatically in FIG. 10B where it will be observed that each of the information leads 178, 180, 182, 184 and 186 enter from the left. The lead 176, which is supplied with a pulse for each frame of information, also is shown and is connected through a delay circuit 200 to a shift pulse conductor 204. The delay circuit at 200 can be of any suitable type; its function merely is to receive a pulse on the input side simultaneously with energization of relays 124, 126, 128 and 132 and to insure that all of these relays have had time to operate and restore before a pulse appears in the lead 204.

The signal input lead 178 is connected to a box 206 which is one unit of an information matrix which is shown in greater detail diagrammatically in FIG. 11. Here it will be seen that energization of the lead 178 operates to polarize a magnetic ring 208 in one direction. A pulse in the lead 204 has the effect of polarizing the ring 208 in the opposite direction. A third coil 210, wound on the core 208, supplies an output circuit connected through a diode 212 and lead 214 and thence through a delay circuit 216 to output leads 218. These leads are connected in turn to the next stage, which is identical to the one shown. A diode 220 is also connected across the input to the delay circuit 216. This circuit operates as follows: A pulse in the shift pulse conductor 204 polarizes the ring 208 in one direction. If, now, a pulse is supplied by way of the lead 178, the ring 208 is polarized in the opposite direction. This change in polarity tends to send a voltage pulse through the output coil 210, but this is stopped by the diode 212. The next resetting pulse in the lead 204, however, reverses the polarity once again, and this produces an output pulse through the delay circuit 216 so as to shift the information from the memory stage shown to the next in the series. On the other hand, if the ring 208 has been polarized by a pulse in the lead 204 and then the next shift pulse is applied to the lead 204 without any intervening pulse on the lead 178, the polarity of the ring 208 is unchanged and therefore no pulse appears in the output circuit coil 210.

The diode 220 prevents feedback of a pulse from the succeeding stage to the coil 210. More specifically, when a shift pulse reverses the ring polarity in the succeeding stage 230, a pulse is produced in the input coil of stage 230. The pulse so produced is of a polarity such that the positive potential is at the bottom of the coil. Diode 212 is polarized to accept this pulse, but diode 220 will shunt the pulse.

In the circuit of 10B, the information from one frame of eight stripes, such as the letter P in FIG. 5 for instance, is transferred through the lines 178, 180, 182, 184 and 186 and stored in the matrix elements 206, 222, 224, 226 and 228, all of these being duplicates of the one shown at 206 in FIG. 11. After a short delay established by the circuit at 200, a pulse appears in the lead 204 and shifts the information to the next stage shown at 230, 232, 234, 236 and 238. The first stage at 206, 222, 224, 226 and 228, is therefore stripped of information and is prepared to receive that contained in the next eight bar segment of the panel shown in FIG. 5. As successive information frames are brought into position to be observed by the photocells the information is shifted from stage to stage until the first information received is transferred to the last of the stages indicated at 240, 242, 244, 246 and 248. Although only three stages are shown in FIG. 10B, it will be appreciated that the number of stages required is equivalent to the number of information frames on the coded panel plus one. In the present instance this amounts to 17 stages.

Once the matrix is full of information, it can be shifted out a stage at a time from the last stage 240, 242, 244, 246 and 248 by applying additional shift pulses to the line 204, these output lines being represented in order by the numerals 250, 252, 254, 256 and 258.

As previously explained, depending upon the direction of travel of the car past the reader, the information may be in the matrix in the proper order, or it may be reversed. In order to accommodate for this situation, a second memory matrix is supplied and is indicated generally by the numeral 260. It is substantially like the first excepting that information is not read into it a letter or character at a time, but rather transferred thereto all at once; and it therefore can have one less stage than the initial matrix. The stages in the second or number 2 matrix are interconnected as are those in the first matrix, excepting that, when shifting pulses are supplied to the line 204, the information travels through the matrix toward the left rather than toward the right. The output leads which correspond in order with leads 250, 252, 254, 256 and 258, are therefore leads 270, 272, 274, 276 and 278. For convenience, the leads having the same information are shown paired at the right hand edge of FIG. 10B.

Shifting of the information from the main register or matrix to the second register at 260 is accomplished by interconnecting each stage of the main register, except the input stage, with a corresponding stage of the second register. The matrix element 230, for instance, is connected through an "and" circuit 280 to the input lead of an appropriate matrix element, 282 for instance, of the second matrix. The "and" circuit 280 is arranged to transfer the information from matrix 230 to 282 when a lead 284 connected to the "and" circuit is energized. These "and" circuits may be of any conventional type, such as relays for instance.

Thus the information can be fed into the lower matrix a stage at a time until the matrix is full, the last frame of information received being stored in the second stage at 230, 232, 234, 236, and 238. Thereafter a potential on the lead 284 along with a shift pulse in lead 204 will shift this information simultaneously to the second storage matrix. Thereafter, shift pulses applied to the lead 204 will shift information from the second register 260 with the last to be received being the first to be read out.

Referring now to FIG. 10C, the paired outlet leads from the circuit 10B are shown at the left. Each of the leads 250, 252, 254, 256 and 258 is shown as being connected to a fixed relay contact, these contacts in order being indicated by the numerals 290, 292, 294, 296 and 298. Each of these contacts is normally engaged by a movable relay contact 300, 302, 304, 306, and 308, respectively. These movable contacts are ganged together to be operated by a relay coil indicated at 309. Whenever this coil is energized, the circuit through contacts 290, 292, 294, 296, and 298 is opened and contacts 300, 302, 304, 306, and 308 engage, respectively, a second set of contacts 310, 312, 314, 316, and 318.

Each of the movable relay contacts 300, 302, 304, 306 and 308 is connected into a code relay circuit, these circuits being indicated generally in order by the numerals 320, 322, 324, 326 and 328. Thus, the leads 250, 252, 254, 256 and 258 from the first matrix are connected through contacts, respectively, 300, 302, 304, 306 and 308 when the relay coil 309 is deenergized, so as to feed into the code relays at 320, 322, 324, 326 and 328. On the other hand, if the relay 309 is energized, the contacts 300, 302, 304, 306 and 308 are shifted so that the information fed into the code relays is from the leads 270, 272, 274, 276 and 278, which originate at the second or reversing matrix.

The code relays are all identical; and only one, therefore, needs to be explained. As shown at 320, the input lead from the relay terminal 300 is connected through a relay coil 330 to ground. Whenever relay coil 330 is energized, it closes a set of contacts 332, which connect a relay power lead 334, maintained at 24 volts for instance, with one of the input terminals 336 of a standard high speed parallel to sequential Teletype transmitter indicated generally by the numeral 338.

Whenever the contacts 332 are closed, this also establishes a holding circuit for the relay coil 330 by way of relay contacts 332 and a set of normally closed relay contacts 340 connected to the coil 330. Contacts 340 are adapted to be opened momentarily whenever a pulse is applied to a line 342 connected to a relay coil 344 which operates contacts 340. Thus a pulse entering the code relay from the last stage of one of the registers by way of contact 300 acts to close contacts 332 and energize one of the parallel input transmitter terminals 336; and these relay contacts 332 remain closed until a pulse is subsequently applied to the lead 342 after transmission of a character as will be described below.

Code relay 322 has its output lead 346 connected to Teletype transmitter terminal 348, while similarly the output leads of code relays 324, 326 and 328 are connected to transmitter input terminals 350, 352 and 354. The transmitter sweep 356 for each revolution supplies a pulse to the transmitter output lead 358 each time it strikes one of the contacts 336, 348, 350, 352 and 354 which is energized. In any particular location, therefore, an output pulse, or a lack of one, depends upon the information last taken from the storage matrix and entered into the code relays 320, 322, 324, 326 and 328.

After the transmitter sweep 356 has completed a revolution and has sequentially transmitted all of the information for one character, a cam on the sweep shaft momentarily closes contacts at 360, and a similar set at 362. One of the contacts at 360 is connected to a relay operating power line 334, while the other is connected to the previously mentioned shift pulse conductor 204. One of the contacts of the set 362 is also connected to the power line 334, the other contact in this set being connected to a lead 366 connected in turn to the circuit holding relay line 342. Thus, each time the sweep 356 completes sending the information from the last code relay set at 328, contacts 362 are momentarily closed, thereby energizing leads 366 and 342 which energizes the holding circuit relay 344 thereby opening the contacts 340 so as to deenergize the relay 330, with the result that contacts 332 open and condition the code relay to receive additional information from the input lines at the left of FIG. 10C. This action simultaneously takes place in the other identical code relays 322, 324, 326 and 328.

The pulse lead 366 is also connected through a conventional counter at 370 which accumulates a count to 16 and then supplies a pulse to an output lead 372. It follows, therefore, that since each revolution of the transmitter sweep 356 transmits one character, and since there are sixteen characters on the coded panel, a pulse will be supplied to the lead 372 after all of the information has been transmitted from one code panel and the system is to be conditioned to read the panel on the next car in line.

The relay coil 309, previously mentioned, is energized by way of a lead 374. When energized, it shifts the contacts 300, 302, 304, 306 and 308 as previously mentioned. This is to be accomplished when the information has been fed into the number 1 matrix in a backward direction. When coil 309 is energized, it also closes a set of contacts at 376. These contacts are connected between the lead 374 and a holding circuit line 378 connected through a set of normally closed relay contacts 380 to the relay power line 334. The contacts 380 are connected to be opened whenever a relay coil 382 is energized, and this coil is connected to be energized by the lead 372. Thus when a pulse is supplied through the lead 374, indicating that the information in the relay matrix is backward, relay 309 is energized and closes contacts 376 which establishes a holding circuit maintaining this relay in energized condition until all of the information has been taken from the relay matrix. After this has been accomplished, the counter-circuit at 370 will supply a pulse to the lead 372 which energizes relay coil 382 thus separating contacts 380 and interrupting the holding circuit, thereby permitting relay coil 309 to become deenergized. Thus, as each information panel approaches the reader, the reader assumes that the panel will come before it traveling from right to left. If the reader determines that this is not so, the system automatically accommodates for the reversal of the information, but drops back to the original condition after the information from that particular panel has been transmitted.

The standard Teletype transmitter 338 has a set of start-stop contacts indicated at 384. These contacts are connected into the transmitter circuit in such fashion that the transmitter operates whenever these contacts are closed and stands by when the contacts are open. These contacts are normally open, but are closed by a relay coil 386 when energized. After all information from one panel has been stored in the main register, the coil 386 is energized by way of a lead 388 connected into the circuit of FIG. 10B and is held energized by way of relay holding contacts 390 which are normally open, but are arranged to be closed by coil 386 when energized. The circuits causing the operation of coil 386 will be described below. The holding circuit of the coil 386 extends through contacts 390, lead 392, and a set of normally closed relay contacts 394 to the relay power line 334. Relay coil 396 separates contacts 394 when energized by way of lead 398 connected to the line 372 which receives a pulse at the end of transmission of the information on each car.

If, therefore, the lead 388 is energized, contacts 384 will be closed so as to start operation of the transmitter, and contacts 390 will close, thereby establishing a holding circuit so as to keep relay coil 386 energized. After the completion of transmission of the sixteen characters involved in the message, a pulse will appear in the line 372 and by way of lead 398 will energize relay coil 396, thereby separating contact 394 so as to interrupt the holding circuit for relay coil 386, thereby placing the Teletype transmitter in standby condition.

Referring now to FIG. 10D, it will be noted that the line 190 when energized actuates a relay coil 400 by way of a feedback preventing diode 460. This lead it will be remembered is from FIG. 10A and is energized whenever the black-white-white design at the left hand edge of FIG. 5 is before the reader. Similarly, the lead 188, energized when the end design of white-white-black is before the reader is connected to energize its relay coil 402 by way of a feedback preventing diode 461. Coil 400 is also energized by way of normally closed holding contacts 404 connected to a 24 volt relay operating line 406. Contacts 404 are opened whenever relay coil 400 is energized. This coil is connected, by way of a feedback preventing

diode 462, to lead 398 previously mentioned in connection with FIG. 10C as receiving a pulse at the end of transmission of the entire intelligence from a coded panel.

Relay coil 400 operates when energized to open a set of normally closed contacts 410 connected between the lead 398 and the relay power supply lead 406. Thus when relay coil 400 is deenergized, contacts 410 are closed, thereby supplying energy to relay coil 408. Energization of this coil maintains contacts 404 separated so that relay coil 400 stays deenergized until a pulse arrives through the lead 190. This momentarily energizes coil 400 and opens contacts 410. Coil 408, therefore, becomes deenergized and permits contacts 404 to close, thereby establishing a holding circuit for coil 400, with the result that contacts 410 are maintained in separated condition until a pulse arrives by way of the lead 398. Such a pulse momentarily energizes coil 408 and resets the cycle.

Lead 188 is connected to relay coil 402, and this coil when energized separates contacts 412 which are connected between the relay energizing line 406 and the branch 414 from lead 398 to relay coil 416. This latter coil, when energized, operates to open contacts 418 in a circuit between relay power line 406 and coil 402. This arrangement it will be appreciated is a duplicate of the one described above and operates in such fashion that a pulse in the lead 188 energizes coil 402 which remains energized until a pulse arrives by way of the lead 398 and a feedback preventing diode 463 to deenergize coil 402 until the following pulse is applied to lead 188.

Coil 400 also operates when energized to close normally open contacts 420 connected between line 188 and lead 422. Similarly, normally open contacts 424 are connected between lead 190 and lead 426, contacts 424 being closed whenever relay coil 402 is energized. Lead 422 is connected to relay coil 428, while lead 426 is similarly connected to relay coil 430, leads 422 and 426 being interconnected through a diode 432 so oriented that energization of line 422 energizes relay 428 only, whereas energization of lead 426 operates to energize both relay coils 428 and 430.

The circuit is such that if a pulse arrives by way of the lead 190, contacts 420 are closed and maintained closed so that subsequently if the coded panel is passing the reader from right to left, indicating that the information is in the proper order, lead 188 will subsequently be pulsed when the last frame on the panel registers with the reader. This pulse travels by way of contacts 420 and energizes lead 422. On the other hand, if a pulse arrives by way of the lead 188 first, it energizes relay coil 402, thereby closing contacts 424 so that subsequently, when a pulse arrives by way of the lead 190 it is conducted by way of contacts 424 to lead 426 and thence to relay coils 430 and 428 simultaneously.

Energization of relay coil 428 closes contacts 434 connected between power lead 406 and line 388 of FIG. 10C. It will be remembered that, as described above, a pulse on line 388 operates the relay coil 386 to start the transmitter 338. Thus receipt of both the start and finish signals from the panel of FIG. 5 acts to start operation of the Teletype transmitter, since the receipt of both of these signals is an indication that all of the information has been stored within the memory system. Energization of coil 428 also closes contacts 436 connected between power line 406 and relay coil 438. Energization of coil 438 closes contacts 440 connected between the power line 406 and shift pulse lead 204 of FIG. 10B. Thus the receipt of both the start and finish code information, after a time delay introduced by the time of operation of the relay 438, introduces a shift pulse which shifts the information stored in the last group of memory units in the matrix 240, 242, 244, 246 and 248, for instance, into the code relays.

If in addition to the above, relay coil 430 is also energized, indicating that the information is stored in the number one matrix backward, relay coil 430 operates to close contacts 442, which energizes lead 374 of FIG. 10C. This energizes relay coil 309 previously described, which shifts relay contacts 300, 302, 304, 306 and 308 so that the information is read into the code relay from the No. 2 information storage system.

Energization of coil 430 also closes relay contacts 444 connected between power line 406 and line 284 of FIG. 10B. Reference to this circuit will show that this lead comprises one side of the "and" circuits interconnecting the No. 1 storage with the No. 2 storage. Relay coil 430, when energized, also closes a third set of contacts 446 connected between the power lead 406 and the shift pulse lead 204 which operates in FIG. 10B to shift information one stage toward the right in the storage matrix of the No. 1 storage.

With battery potential applied to conductor 284 of the "and" circuits such as circuit 280, the shift pulse will transfer the information from the main storage to the No. 2 storage in a well known manner. Therefore, when the information has been taken from the information panel in a reverse direction, relay 430 will shift the information one stage to the right out of each of the matrix units of the No. 1 storage and thence by way of the "and" circuits, 280 for instance, to the No. 2 storage; and, after a short time delay provided by the sequential operation of relays 428 and 438, another pulse will be supplied to the No. 2 storage which will shift the information one stage from the No. 2 storage toward the left into the code relays.

In general, therefore, and with reference to FIG. 6, information picked up from the card or panel of the type shown in FIG. 5 is sensed two bands at a time, and this information is transmitted by way of the photocell system of FIGS. 7, 8 and 10A to the No. 1 storage which forms the subject matter of the lower portion of FIG. 10B, from which it is shifted character by character to the right. This process continues until the No. 1 storage is full and all of the information has been taken from the panel. At this juncture, the detection and control circuit of FIG. 10D operates relay contacts which connect the output either of the No. 1 storage, or alternatively the output of the No. 2 storage, to the code relays. Also if the detection and control circuit determines that the information is in the No. 1 storage in a backward condition, the transfer gate is actuated to shift the information to the No. 2 storage so that it can be read out in the reverse direction. The information from either the No. 1 or the No. 2 storage, therefore, is fed into the code relays, one character at a time, and is shifted from the code relays to the information sequential transmitter which is started and stopped through operation of the detection and control circuit and which feeds back signals to the code relays and the storage system to advance new information as old information is taken from the information transmitter.

From there on, the information in line 450 for instance, being in standard Teletype code and sent by standard Teletype equipment, is acceptable by many types of compatible devices such as Teletype printers, card punches, tape punches, and so on. Because the speed of operation of the system should be high enough to accommodate information taken from moving railway cars at speeds up to one hundred miles an hour, or so, it is preferable if the information transmitter reads directly into a tape punch or other high speed permanent storage system from which it can be taken at leisure and used for punching cards or for other purposes.

As is well known, the "line feed" character of FIG. 5 is used in Teletype systems to separate succeeding messages, etc.

A variation of the above described system based upon simultaneous reading of all of the coded information, that is, the system of FIGS. 2, 4, 9, 12A and 12B, is essentially similar to the character by character system, but differs principally in that all of the information from the reader is simultaneously put into the storage matrix in a parallel manner, and once therein is always in the proper order.

It therefore always can be taken from one end of the matrix serially without provision for reversing the information prior to this operation. The No. 2 matrix is therefore not necessary and some of the control equipment (that of FIG. 10, for instance) can be omitted from the circuit.

It will also be noted that, since all information is read from the card simultaneously, the code stripes can be arranged in any arbitrary manner on the card. Obviously, the photocells in the reader must be correspondingly arranged.

Referring now to FIGS. 12A and B, a photocell and amplifier is shown within the box 500. This is identical to the arrangement indicated at 81 in FIG. 10A; and, as previously described, any suitable photoelectric device can be used, such as a photo multiplier tube or a junction transistor, for instance, depending upon the preference of the manufacturer and upon the sensitivity desired. Other photocells and amplifiers are indicated by even numbers from 502 to 534. All of these units are identical and each is placed to read a stripe on the panel of FIG. 4, the first three, that is, 500, 502 and 504, being in a position to sense the frame position bands 54 and 56 and the dark band therebetween. Specifically with respect to FIG. 4, the photo-sensitive units 506 to 514 sense the letter P, from 516 to 524 the first letter R, and 526 to 534 the last character, "line feed," the circuits which sense the region beyond the first letter R and through the last letter D being omitted from the drawing in order to conserve space.

The photo-sensitive units 500 to 534 operate relay coils numbered, respectively, by even numbers from 540 to 574. Each of these coils operates a single pole, double throw, set of relay contacts numbered, respectively, as follows: The movable contacts are indicated in order by the even numbers from 580 to 614, the contacts which are normally closed against the movable contacts by the numbers 620 to 654. The contacts which are normally open and are closed against the movable contact when the coils are energized, are numbered in succession by even numbers from 660 to 694. With the exception of contact 662, the latter group are unconnected and act simply as stops.

As in the embodiment illustrated in FIG. 10A, the ends of the relay coils 540 to 574 not connected to the photocell amplifiers are connected to a B+ line 116, so that conduction through the photocell units brought about by the presence of a black stripe, causes energization of the solenoids and a consequent shifting of the movable relay contacts.

A line 170 carrying a relay operating voltage of 24 volts or so is connected to the movable contact 580, and the contact 620 against which it is normally closed is connected by a lead 700 to contact 662. The movable contact associated therewith, 582, is connected by a lead 702 to movable relay contact 584; and the contact 624 against which contact 584 is normally closed is connected to a pulse line 704. This arrangement, it will be noted, like that of FIG. 10A results in the line 704 receiving a pulse whenever photocell units 500 and 504 observe a white stripe at the same time as a black stripe is before photocell unit 502.

The pulse lead 704 is connected to each of the movable relay contacts from 586 to 614. Each of the normally closed fixed relay contacts from 626 to 654 are connected to output leads numbered successively from 706 to 734. These leads, as in the previous instance, go to the memory matrix illustrated along the bottom half of FIGS. 12A and 12B.

The matrix consists of five parallel channels with each channel in the present instance having sixteen stages in series. In order to avoid complexity, only three stages in series are shown in each of the parallel branches. The five stages in parallel at the output end of the matrix are indicated by the numerals 736, 738, 740, 742 and 744. The next group of five are indicated in order by the numerals 746 to 754, and the last group by the numerals 756 to 764. The individual first and second units in each of the series branches are connected together by lines 766 to 774. Similar leads 776 to 784 extend from the unit 746 to 754 to the next in line, while the last units 756 to 764 are connected in turn to the previously mentioned leads 726 to 734. Also leads 716 to 724 are connected in turn to the matrix interconnecting leads 776 to 784, respectively, and leads 706 to 714 are connected to matrix leads 766 to 774.

Thus whenever the photo-sensitive units 500, 502 and 504 sense the triggering stripes 54, 56 and the intervening black stripe, the lead 704 will receive a pulse which will pass through appropriate relay contacts of the individual stripe sensing photocell circuits wherever a particular photocell is observing a white stripe, with the result that its associated matrix unit will receive and store this information. As an example, if the photocell unit 506 observes a black stripe, this energizes coil 546 which opens contacts 586—626 with the result that no pulse is received by the storage unit at 736. If at the same time, photocell unit 508 is observing a white stripe so that coil 548 remains deenergized, then the pulse will appear from lead 704 by way of contacts 628—588 to lead 788 and line 760 so that this information is stored in the matrix element 738.

Thus all of the information from all of the photocell circuits representing all of the stripes on the coded panel, is set into the information storage matrix simultaneously. When a pulse appears in the lead 780, this lead being connected to the shift circuit of each of the units in the matrix, the information advances toward the left so that one pulse causes the information to read out from the matrix 736, 738, 740, 742 and 744 into leads 782, 784, 786, 788 and 790, which are the counterparts of contacts 300, 302, 304, 306 and 308 of FIG. 10C, which lead into the code relays. From here on the circuit is substantially the same as FIG. 10C.

As with FIG. 10C, operation of the teletype transmitter at 338 sends pulses into lead 204 which may be considered as connected to lead 780 of FIGS. 12B and 12A. That is, this lead is connected to each of the matrix elements and acts to advance the information toward the left in the matrix, or from the last stage at 736 to 744, whenever this lead is pulsed. Lead 704 is also connected through a delay circuit 800 to lead 780, so that shortly after the information is stored in the matrix, that in the first stage is shifted out to the code relays to start the transmitting cycle. Lead 788 of FIG. 12 is also connected to terminal 388 of FIG. 10C, so that the transmitter is placed in operation when the first frame of information has been shifted to the code relays.

While we have shown and described particular embodiments of our invention, it will be aparent to those skilled in the art that numerous modifications and variations may be made without departing from the underlying principles of the invention. We therefore desire, by the following claims, to include within the scope of the invention all such modifications and variations by which substantially the results thereof may be obtained by substantially the same or equivalent means.

We claim:

1. Apparatus for transmitting, detecting and recording intelligence between railway cars and a fixed station as said cars move past a pickup device at any normal operating speed comprising: a panel forming a portion of each car; code markings distinctive of certain intelligence on each said panel, said code markings comprising photo differing elements positioned on said panel in successive groups for group-by-group detection; a framing set of code markings associated with each group of intelligence code markings and positioned on the panel in a fixed position relative to the position of its associated intelligence code marking group; said pickup device including a first group of photosensitive devices for detecting all of one group of intelligence code markings simultaneously, a

second group of photosensitive devices for detecting said framing sets of code markings; means for focusing each of said sets of markings upon the respective groups of photosensitive devices simultaneously when a car is appropriately positioned with respect to said pickup device, a storage device for recording intelligence in coded form; circuit means connected with said first group of photosensitive devices for supplying information to said storage device when triggered, and circuit means actuated by said second group of photosensitive devices to trigger the first said circuit means when said second group of photosensitive devices detect a set of frame code markings.

2. Apparatus for transmitting, detecting and recording intelligence between railway cars and a fixed station as said cars move past a pickup device at any normal operating speed comprising: a panel forming a portion of each car; code markings distinctive of certain intelligence on each said panel, said code markings comprising photo differing elements positioned on said panel in successive groups for group-by-group detection; a framing set of code markings associated with each group of intelligence code markings and positioned on the panel in a fixed position relative to the position of its associated intelligence code marking group; said pickup device including a first group of photosensitive devices for detecting all of one group of intelligence code markings simultaneously, a second group of photosensitive devices for detecting said framing sets of code markings; means for focusing each of said sets of markings upon the respective groups of photosensitive devices simultaneously when a car is appropriately positioned with respect to said pickup device, a temporary storage device for recording intelligence in coded form; circuit means connected with said first group of photosensitive devices for supplying information to said temporary storage device when triggered, circuit means actuated by said second group of photosensitive devices to trigger the first said circuit when said second group of photosensitive devices detects a set of frame code markings, a third set of code markings having at least two longitudinally spaced differing code elements on said panel, such that the order of presentation of said differing elements as a car moves past a stationary pickup device informs as to the direction of movement of said car and hence as to the natural or reverse order of presentation of said intelligence groups, means sensitive to said third set of markings, a second information storage system, and means responsive to the last said sensitive means to convey information from said temporary storage device to said second storage system in the order received by said temporary storage device or in the reverse order depending upon the order of presentation of the code elements in said third set of markings to said pickup device.

3. In a system for recording data from railway cars while such cars are in motion, the combination comprising means on individual cars for indicating data peculiar to that car, said indicating means comprising a panel having a plurality of vertical bar markings thereon so arranged that the photoreflecting ability and relative positions of said markings on said panel present said data in binary code, trackside stationary photosensitive pickup means for generating signals when triggered as said cars move past said pickup means in response to said indicating means, means for triggering said pickup means when a panel is in appropriate position before said pickup means, and means responsive to said signals to store the information provided by said indicating means.

4. In a system for recording data from railway cars while such cars are in motion, the combination comprising means on individual cars for indicating data peculiar to that car, said indicating means comprising a panel having a plurality of vertical bar markings thereon so arranged that the photoreflecting ability and relative positions of said markings on said panel present said data in code, trackside stationary photosensitive pickup means for generating signals when triggered as said cars move past said pickup means in response to the photoreflecting ability and positions of said bars, means for triggering said pickup means when a panel is in appropriate position before said pickup means, and an information storage matrix of binary elements adapted to reproduce the pattern of said bars in response to said signals.

5. In a system for recording data from railway cars while such cars are in motion, the combination comprising means on individual cars for indicating data peculiar to that car in photocontrasting binary code, trackside stationary photoelectric pickup means responsive to the indicating means for generating binary coded signals when a car in a train moves past said pickup means, a binary register responsive to said signals to store temporarily the information provided by said indicating means, means adapted when actuated to prevent said signals from affecting said register and to translate the temporarily stored information out of said binary register before the next car in the train moves past said pickup means, means for actuating said translating means when all of the data from one car has been stored in said temporary storage means, and means actuated when all of the information has been translated out of said temporary storage means to reset said binary register for data peculiar to the next adjacent car in the train.

6. Apparatus for transmitting, detecting and recording intelligence between railway cars and a fixed station as said cars move past a pickup device at any normal operating speed comprising: a panel forming a portion of each car; binary code markings distinctive of certain intelligence on each said panel, said markings comprising a pattern of vertical bars with five of said bars representing a conventional symbol, said bars each comprising one of two photo differing elements positioned on said panel in successive groups of five so that each group represents a conventional symbol, a framing set of code markings associated with each group of intelligence code markings and positioned on the panel in a fixed position relative to the position of its associated intelligence code marking group; said pickup device including a first group of photosensitive devices for detecting all of one group of intelligence code markings simultaneously, a second group of photosensitive devices for detecting said framing sets of code markings; means for focusing each of said sets of markings upon the respective groups of photosensitive devices simultaneously when a car is appropriately positioned with respect to said pickup device, a binary storage matrix for recording intelligence in coded form; circuit means connected with said first group of photosensitive devices for supplying information as to one intelligence group to said binary storage matrix simultaneously when actuated, circuit means actuated by said second group of photosensitive devices to actuate the first said circuit whenever said second group of photosensitive devices detects a set of frame code markings, a third set of code markings having at least two longitudinally spaced differing code elements on said panel such that the time order of presentation of said differing elements as a car moves past a stationary pickup device informs as to the direction of movement of said car and hence as to the natural or reverse order of storage of said intelligence groups, circuit means sensitive to said third set of markings, a second information storage system, and means responsive to the last said sensitive means to convey information from said binary matrix, a group at a time, to said second storage system in the order received by said matrix, or in the reverse order depending upon the order of presentation of the code elements in said third set of markings to the last said sensitive means.

7. In a system for recording data from railway cars while such cars are in motion, the combination comprising a car panel having a plurality of vertically elongated photocontrasting markings corresponding to the data in binary code, the panel having additional vertically elongated photocontrasting markings positioned in a predetermined manner relative to the data markings, photosensitive pickup means responsive to the data markings generating signals corresponding to the data, additional photosensitive pickup means positioned in predetermined relation to the first mentioned pickup means and responsive to the additional markings to render the first mentioned pickup means effective for generating signals only when the data markings are in an optimum detection position before the first mentioned pickup means.

8. In a system for recording data from railway cars while such cars are in motion, the combination comprising a car panel having a plurality of vertically elongated photocontrasting markings corresponding to the data in binary code, the panel having additional vertically elongated photocontrasting markings of less width than the code markings and positioned in a predetermined manner relative to the data markings, photosensitive pickup means responsive to the data markings generating signals corresponding to the data, additional photosensitive pickup means positioned in predetermined relation to the first mentioned pickup means responsive to the additional markings to render the first mentioned pickup means effective for generating signals only when the data markings are in an optimum detection position before the first mentioned pickup means.

9. In a system for recording data from railway cars while such cars are in motion, the combination comprising a car panel having a plurality of horizontally contiguous vertically elongated photocontrasting markings corresponding to the data in binary code, the panel having additional vertically elongated photocontrasting markings of less width than the code markings and positioned with their horizontal midpoints corresponding to code marking midpoints, photosensitive pickup means responsive to the data markings generating signals corresponding to the data, additional photosensitive pickup means positioned with their horizontal midpoints corresponding to the first mentioned pickup means and responsive to the additional markings to render the first mentioned pickup means effective for generating signals only when the data markings are horizontally centered before the first mentioned pickup means.

10. The combination of claim 9 in which the data markings and the additional markings are arranged horizontally for group-by-group detection together with a multi-stage shift register serially storing the data in response to succeeding groups of signals.

11. In a system for recording data from railway cars while such cars are in motion at speeds as high as 100 miles per hour, the combination comprising a car panel having a plurality of contiguous vertically elongated photocontrasting markings in the order of 6" x 1" corresponding to the data in binary code, the panel having additional vertically elongated photocontrasting markings in the order of 6" x ½" with their horizontal centers corresponding to the centers of certain of the code markings positioned in a predetermined manner relative to the data markings, photosensitive pickup means responsive to the data markings generating signals corresponding to the data, additional photosensitive pickup means adapted for sensing the midpoints of the additional markings when the first mentioned pickup means sense the midpoints of data markings and responsive to the additional markings to render the first mentioned pickup means effective for generating signals only when the data markings are horizontally centered for detection by the first mentioned pickup means.

12. The combination of claim 11 together with means including a lens normally focusing a vertically central circular portion of the markings approximately 1" in diameter upon the respective pickup means when the car bearing the panel is free of sway and of settling due to heavy loading.

13. In a system for recording data from a series of connected railway cars while such cars are in motion, the combination comprising a panel on each car indicating data peculiar to that car in photocontrasting binary code, the markings being grouped in a space relatively short in relation to the length of the car, stationary photosensitive pickup means responsive to the coded data for generating binary code signals corresponding to the data as the panel moves past the pickup means, a binary register responsive to the signals to store the data temporarily, a permanent storage means, circuit means effective when all of the data on a panel is stored in the register for transferring the data to the permanent storage means before the panel of the next succeeding car moves into position before the pickup means, and circuit means effective upon transfer of all of the data to the permanent storage means to condition the register and the first mentioned circuit means for receiving and transferring data peculiar to the next succeeding car.

14. In a system for recording data from a series of connected railway cars while such cars are in motion, the combination comprising a panel on each car indicating data peculiar to that car in photocontrasting binary code, the markings being grouped in a space relatively short in relation to the length of the car, stationary photosensitive pickup means responsive to the coded data for generating signals corresponding to the data as the panel moves past the pickup means, a register responsive to the signals to store the data temporarily, a permanent storage means, and circuit means effective when all of the data on a panel is stored in the register for transferring the data to the permanent storage means before the panel of the next succeeding car moves into position before the pickup means.

15. In a system for recording data from a series of connected railway cars while such cars are in motion, the combination comprising a panel forming a portion of each car, photocontrasting data markings on the panel positioned in sucessive groups lengthwise of the panel for group-by-group detection, the first group corresponding to a start of data indication and the last group corresponding to the end of data indication, an additional group of photocontrasting markings for each of the data groups and positioned in a predetermined manner relative thereto, a first set of photosensitive pickup means responsive to each group of data markings for generating signals corresponding thereto, additional photosensitive pickup means positioned in predetermined relation to the first mentioned pickup means and responsive to the additional markings to render the first mentioned pickup means effective for generating signals only when each group of data markings is in an appropriate position before the first mentioned pickup means, a shift register responsive to each group of signals from the first mentioned pickup means for temporarily storing the data in the order received, a second shift register, circuit means responsive to the start and end of code signals for transferring the data from the first shift register to the second shift register in the event that the end of data signals precede the start of data signals, additional data storage means, and circuit means responsive to the start and end of data signals to cause transfer of the stored data alternatively from the first shift register group-by-group in the order in which the data is detected by the pickup means or group-by-group from the second shift register in the reverse order to the additional storage means, whereby data is detected and stored in proper order irrespective of the direction in which the train passes pickup means.

16. In a system for recording data from a series of connected railway cars while such cars are in motion, the combination comprising a panel forming a portion of each car, vertically elongated photocontrasting data markings on the panel positioned in successive groups lengthwise of the panel for group-by-group detection, the first group corresponding to a start of data indication and the last group corresponding to an end of data indication, an

additional group of photocontrasting markings for each of the data groups and positioned in a predetermined manner relative thereto, the additional markings being horizontally narrower than the data markings, a first set of photosensitive pickup means responsive to each group of data markings for generating signals corresponding thereto, additional photosensitive pickup means positioned in predetermined relation to the first mentioned pickup means and responsive to the additional markings to render the first mentioned pickup means effective for generating signals only when each group of data markings is in a centered position before the first mentioned pickup means, a shift register responsive to each group of signals from the first mentioned pickup means for temporarily storing the data in the order received, a second shift register circuit means responsive to the start and end of code signals for transferring the data from the first shift register to the second shift register in the event that the end of data signals precede the start of data signals, additional data storage means, and circuit means responsive to the start and end of data signals to cause transfer of the stored data alternatively from the first shift register group-by-group in the order in which the data is detected by the pickup means or group-by-group from the second shift register in the reverse order to the additional storage means, whereby data is detected and stored in proper order irrespective of the direction in which the train passes pickup means.

17. In a system for recording data from a series of connected railway cars while such cars are in motion, the combination comprising a panel forming a portion of each car, vertically elongated photocontrasting data markings on the panel positioned in successive groups lengthwise of the panel for group-by-group detection, the first group corresponding to a start of data indication and the last group corresponding to an end of data indication, an additional group of photocontrasting markings for each of the data groups and positioned in a predetermined manner relative thereto, the additional markings being horizontally narrower than the data markings, a first set of photosensitive pickup means responsive to each group of data markings for generating signals corresponding thereto, additional photosensitive pickup means positioned in predetermined relation to the first mentioned pickup means and responsive to the additional markings to render the first mentioned pickup means effective for generating signals only when each group of data markings is in a centered position before the first mentioned pickup means, a stationary, multi-stage shift register responsive to each group of signals from the first mentioned pickup means for temporarily storing the data in the first stage, time delay circuit means controlled by the additional pickup means shifting the stored data one stage during the interval between successive groups of data signals, a second stationary, multi-stage shift register, circuit means responsive to the start and end of code signals for transferring the data from the first shift register to the second shift register in the event that the end of data signals precede the start of the data signals, additional data storage means, and circuit means responsive to the start and end of data signals to cause transfer of the stored data alternatively from the first shift register group-by-group in the order in which the data is detected by the pickup means or group-by-group from the second shift register in the reverse order to the additional storage means, whereby data is detected and stored in proper order irrespective of the direction in which the train passes pickup means.

18. In a system for detecting and recording data carried by railway cars while such cars are in motion, the combination comprising a panel on each car having a plurality of vertically elongated photocontrasting markings corresponding to data peculiar to that car in binary code, the markings arranged in horizontally succeeding groups on each panel for sequential group-by-group detection, trackside photosensitive pickup means responsive to the data markings as they pass the pickup means and effective when triggered for generating signals corresponding to the data markings, means triggering the pickup means when each marking group is in an appropriate position before the pickup means, a multi-stage stationary shift register responsive to the signals corresponding to each marking group for storing the marking group in its first stage, time delay circuit means responsive to the triggering means applying a shift pulse to the shift register stages to advance the marking groups one stage during the interval between the detection of succeeding marking groups, a permanent storage means, and circuit means effective when all of the data on one panel is stored in the shift register for periodically applying shift pulses to the shift register to transfer the data serially from the shift register into the storage means during intervals between the detection of the data on each panel.

19. In a system for detecting and recording data carried by railway cars while such cars are in motion, the combination comprising a panel on each car having a plurality of vertically elongated photocontrasting markings corresponding to data peculiar to that car in binary code, trackside photosensitive pickup means responsive to the data markings as they pass the pickup means and effective when triggered for generating signals corresponding to the data, means triggering the pickup means when a panel is in an appropriate position before the pickup means, a stationary shift register responsive to the signals for temporarily storing the data, a permanent storage means, and circuit means effective when all of the data on one panel is stored in the shift register for periodically applying shift pulses to the shift register to transfer the data serially from the shift register into the storage means during intervals between the detection of the data on each panel.

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